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FOSSIL GRASSES AND SEDGES.[1]

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IN number of species the Glumales (Graminales, Poales) is one of the greatest angiospermous alliances. Aside from the forms known as weeds or the cultivated species which have been generally distributed by commerce and colonization, the group is cosmopolitan, with common species in the northern and southern as well as the eastern and western hemispheres. The distribution is very uniform, no one tribe or large genus being confined to a single geographic area, abundant proof in itself that the Glumales are an old type, whose generic evolution occurred far back in geological history.

The known geological record does not, however, throw much light on this subject. From the nature of the case the most we can expect of fossil grasses and sedges is that they will give us some idea when these types first appeared on the globe and when they became abundant and widespread. We cannot expect to unravel the botanical affinities of stray bits of leaf or indefinite remains of inflorescence (Panicum), culms (Culmites), or rhizomes (Rhizocaulon) in plants whose leaf-form and general struc-

[1] Published by permission of the Maryland Geological Survey.

ture is so uniform; nor can the names bestowed upon these remains be taken to indicate relationship with the modern forms except in a most generalized sense, indicating rather the personal preference or convenience of their describers. However, as organic remains of frequent occurrence and definite character they deserve a place in fossil floras, and are perhaps more useful to the geologist than to the botanist.

Summarizing the described species, we may note that we have no evidence of grasses nor of sedges during the Paleozoic. When parallel-veined leaves were supposed to indicate exclusively Monocotyledonous character a number of supposed forms were described from the Carboniferous. These have since been found to be Calamarian or Sigillarian leaves. The remains from the older Mesozoic show little improvement in definiteness. We would expect grasses to have existed, and in fact a score of species have been described from the Jurassic (Poacites, Bambusium, etc.). Saporta in particular has described numerous species of grass-like or sedge-like leaves under the name Poacites.[1]

The Cretaceous seems to have been very poorly provided with sedges, if we may judge from the fossils, chiefly described under the name Cyperacites; the grasses, however, are quite numerous during this period (Arundo, Phragmites, Culmites, Poacites, etc.). With the ushering in of the Tertiary, both grasses and sedges become more common, upward of two score species of each type having been described from the Eocene. It is in the Miocene, however, that the greatest display of fossil grasses and sedges is made, there being numerous species founded on culms, glumes, inflorescence, rhizomes, and leaves (Carex, Cyperus, Cyperites, Cyperacites, Oryza, Panicum, Arundo, Arundinites, Phragmites, Bambusa, Uniola, Palæo-Avena, etc.).

Referring more specifically to the Cyperaceæ, it may be noted that the middle and lower Cretaceous of this country, which include the abundant, plant-bearing Potomac beds (Fontaine), the Dakota group (Lesquereux), and the Raritan (Newberry,

[1] As a matter of fact, Poacites as characterized by Brongniart in 1822 was monotypic, and his species having been relegated to synonymy, the name is not available for the Mesozoic species.

Hollick) do not show any recognizable remains of sedges. Dawson has described one doubtful form from the lower Cretaceous (Urgonian) of British Columbia, and Heer has described two species founded on rather more definite remains of leaves from the Kome beds (Urgonian) of Greenland. This paucity of remains renders the discovery of the following species of some importance, as it was evidently abundant in the Atlantic coastal plain at a time when those transition beds between the typical Raritan and the typical Matawan were being laid down.

Carex clarkii sp. nov. (Fig. 1.)

Remains consist of fragments of leaves up to 6 cm. in length, and varying in width from 1.5 to 4 mm., averaging between 2

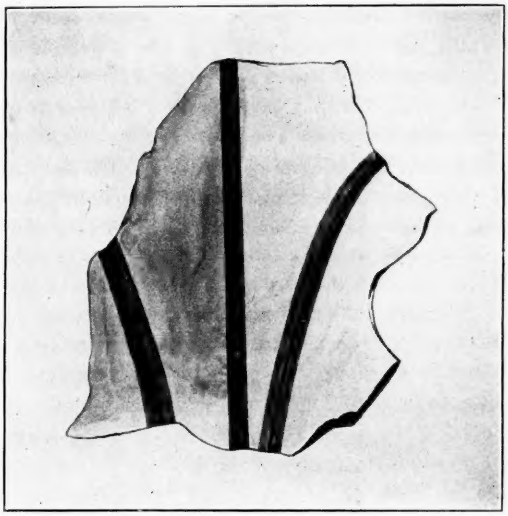

Fig. 1. — Specimen of *Carex clarkii* from Grove Point, Maryland.

and 3 mm. in the specimens collected. Leaves slightly keeled, evidently becoming somewhat thicker and narrower toward the base. Midrib moderately prominent, lateral veins very fine and scarcely discernible, except in the larger specimens.

The type material was collected originally by Dr. Wm. Bullock Clark at Grove Point, Maryland. Similar material has been collected in a different leaf-bed on Grove Point by Bibbins and Berry, who also collected it in less abundance at the Deep Cut of the Chesapeake and Delaware Canal in Delaware. In overhauling my collections from Cliffwood, N. J., I found three small fragments, hitherto undescribed, which are identical with the specimens from further south. I now have twenty-two specimens of this form from the Grove Point locality, five from Deep Cut, and three from Cliffwood. Five specimens were recently collected by the writer from the west bank of Cheesequake Creek one-half mile southwest from Morgan Station.

It has seemed best not to press the comparison with other species from widely different geological horizons too closely. Our species might readily enough be correlated with almost any of the thirty-nine species of Cyperaceæ which Heer describes from the Miocene of Switzerland, and the resemblance is also very close to some of the leaves which Saporta refers to Poacites (*e. g.*, *P. antiquior*, *tenellus*, *cercalinus*). So much confusion results from identifying as common, forms widely separated, either geologically or geographically, when the determinations are based upon any but the most complete material, that it has seemed best to describe the American remains as a new species, as I have no doubt it really is.

PASSAIC, N. J.

CONTRIBUTIONS FROM THE ZOÖLOGICAL LABORATORY OF THE MUSEUM OF COMPARATIVE ZOÖLOGY AT HARVARD COLLEGE. E. L. MARK, DIRECTOR. No. 165.

POSTERIOR CONNECTIONS OF THE LATERAL VEIN OF THE SKATE.

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FOR several years the senior author has used the skate to illustrate to classes in the comparative anatomy of vertebrates the main features of the primitive circulatory system of vertebrates. The injection of the systemic veins of the skate is attended with more or less difficulty, especially at the hands of students of little experience, and even under the most favorable circumstances it is difficult, if not impossible, to secure a complete injection of the veins by the methods ordinarily prescribed (see, for example, T. J. Parker, '95, pp. 48–49). The difficulty lies partly in the fact that the veins are well provided with valves, which impede the flow of the injection mass in a direction the reverse of that of the blood-flow, and partly in the presence of large thin-walled sinuses which are likely to rupture before the injection mass can be forced into the smaller vessels and those more remote from the point of injection. Although a large number of injected skates had come under observation in the laboratory, the relations of certain of the veins in the region of the kidneys had never been clearly demonstrated.

The veins of certain foreign species of skate have been well described, notably by T. J. Parker ('81). Conditions similar to those found in foreign skates are to be expected in our local species. Nevertheless, it seemed to the authors to be worth while to determine precisely the condition of the vessels whose connections were in doubt, especially in view of the fact that there was strong evidence of one striking difference between our common skate and the species described by Parker, in the pos-

terior connections of the lateral veins. The importance of a complete knowledge of the details of skate anatomy is increased by the fact that the skate is, in some respects, so peculiarly adapted for use in the laboratory work of classes in comparative anatomy. In another paper (Rand, :05) attention has been called to the advantages of the skate for this purpose, where also methods of injecting the blood vessels are discussed.

The first complete description of the connections of the lateral vein of the skate is that given by T. J. Parker in his paper "On the Venous System of the Skate (*Raja nasuta*)" in 1881. Previous to Parker's description these veins had been imperfectly described by several anatomists. Monro (:85) observed the lateral veins in skates, but did not determine their posterior extent and connections. Robin ('45) gave an incomplete and not very clear account of the lateral veins of *Raia clavata* L., *R. rubus* L., and *R. batis* L., but at first regarded them as lymphatic vessels. He described the two lateral vessels as inosculating at their posterior ends. He afterwards recognized the true nature of the vessels.

Parker ('81) gave a complete and clear account of the chief veins of *Raia nasuta*. Figure 1 is a diagram showing the connections of the important vessels as represented in the figure accompanying Parker's paper. A similar figure is given in his *Zootomy* ('95, p. 53). According to Parker's account, the lateral vein (*vn. l.*), having received the several brachial veins, opens anteriorly into the precaval sinus. Throughout its extent along the lateral wall of the abdominal cavity, the lateral vessel receives veins from the abdominal walls. The nomenclature used above is not that of the paper cited, but corresponds to that of Parker's later paper ('86) on the blood vessels of *Mustelus antarcticus*. Posteriorly it receives the femoral vein and just back of that point becomes continuous with a large trunk which "passes dorsalwards, ... curving along the posterior wall of the pelvic cavity, then passing on to the lateral wall of the cloaca, along which it takes its course as far as to the rectal gland, where, with its fellow of the opposite side, it enters a hinder prolongation of the cardinal sinus, first receiving numerous small veins from the cloaca and rectum" (Parker, '81, pp. 415–416).

"These latter, I have no doubt," says Parker, "although I have not actually proved it, anastomose with factors of the portal vein" (p. 416). The large trunk which constitutes a direct continuation of the lateral vein from its femoral region into the cardinal sinus was called by Parker the *ilio-hæmorrhoidal vein* because it "seems to correspond in all essential respects to the iliac vein" and "also receives the hæmorrhoidal veins from the rectum and cloaca" (p. 416). The arrangement described by Parker is virtually that of a continuous large venous trunk open-

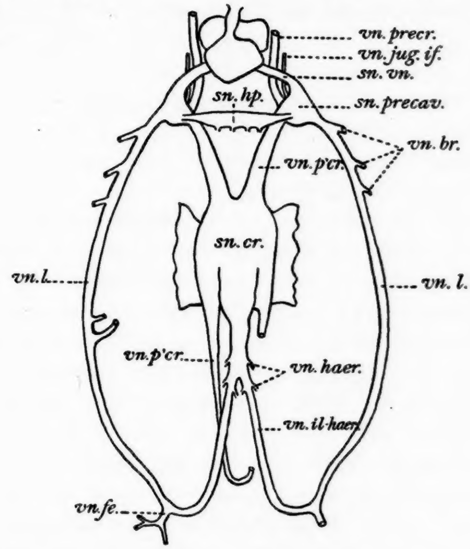

FIG. 1.—Venous system of *Raia nasuta*. After T. J. Parker. *sn. cr.*, cardinal sinus; *sn. hp.*, hepatic sinus; *sn. precav.*, precaval sinus; *sn. vn.*, venous sinus; *vn. br.*, brachial veins; *vn. fe.*, femoral vein; *vn. hær.*, hæmorrhoidal veins; *vn. il-hær.*, ilio-hæmorrhoidal veins; *vn. jug. if.*, inferior jugular vein; *vn. l.*, lateral vein; *vn. p'cr.*, postcardinal vein; *vn. precr.*, precardinal vein.

ing at its anterior end into the precaval sinus and at its posterior end into a posterior extension of the cardinal sinus, its chief tributaries being the brachial and femoral veins and veins from the abdominal wall.

Jourdain ('59) in his "Recherches sur la Veine Porte Rénale," does not mention the lateral veins, but describes the femoral

veins in *Raia clavata* L. as opening each into the corresponding renal portal vein.

Hochstetter ('88) gives the following account of the lateral veins of *Spinax* [= *Squalus*] *acanthias*: "Neben den Venæ subclaviæ münden caudalwärts von ihnen jederseits eine Vene, in die Cardinalvenen, die Seitenvene. . . . . Diese beiden Gefässe wurzeln in einem Venennetze, welches die Kloake umspinnt und mit den Pfortaderzweigen des Enddarmes anastomosirt. Aus diesem Netze gehen rechts und links die beiden Venen hervor, welche angeschlossen an die dorsale Fläche des Beckenknorpels zunächst die Vene der hinteren Extremität aufnehmen und hierauf umbiegend, geradeaus kopfwärts verlaufen und auf diesem Wege die Venen der Bauchmuskeln aufnehmen" (p. 126). In the rays, Hochstetter says, the lateral veins exhibit substantially the same condition as that described for Squalus.

We were led to investigate the posterior connections of the lateral vein of the skate owing to the fact that, in the numerous animals which had come under observation in the laboratory, there had never been seen the least evidence of the "ilio-hæmorrhoidal" trunks described by Parker for *Raia nasuta*. In a freshly-killed skate (*R. erinacea* or *R. lævis*, Fig. 4) the lateral veins, lying just beneath the peritoneum, are conspicuous vessels because of the blood contained in them. They may be followed back to the pelvic region, where they disappear from view. The cardinal sinus is usually well filled with blood and a posterior extension of this sinus may be traced back to the base of the rectal gland. This extension evidently corresponds to the "hinder prolongation of the cardinal sinus" described by Parker as receiving the ilio-hæmorrhoidal veins, but no large trunks are to be seen opening into it. Attempts to trace the uninjected vessels by dissection resulted negatively, so far as any connection between the hind end of the lateral vein and the cardinal sinus is concerned, although a connection of the lateral vein with a vein from the pelvic fin was found. Furthermore, observation of a large number of injected skates had given no evidence of the existence of "ilio-hæmorrhoidal" veins. These injections, however, being of raw starch or of plaster of Paris, were not calculated to show a connection between lateral vein

and cardinal sinus by means of minute vessels, if such existed. Accordingly we undertook to determine if any connection whatever was to be demonstrated.

Six fresh skates were secured, four of them being the common *Raia erinacea* and two *R. lævis.* Our operations and results upon these six animals are described below. In each case the caudal vein was injected for the purpose of differentiating the renal portal connections. The celloidin injections were made with very thin, easily flowing celloidin colored with finely pulverized carmine or Prussian blue. Careful dissections and drawings of the injected vessels were made by Mr. Ulrich.

I. Raia lævis: young male.

1. Renal portal system injected, *via* the caudal vein, with blue celloidin.

Minute separated masses of the celloidin appeared in the postcardinal veins, apparently having passed through the renal capillaries. A considerable quantity of celloidin from this source collected in the cardinal sinus and some of it made its way back into the posterior or rectal prolongation of that sinus.

2. Left lateral vein injected posteriorly with red celloidin.

The red mass appeared on the walls of the cloaca and rectum in a close network of very fine vessels extending forward to, and a little beyond, the base of the rectal gland. Small vessels connected with this network conveyed the celloidin along the ventral margin of the mesorectum, in the region of its attachment to the rectum, apparently into the posterior end of the rectal prolongation of the cardinal sinus. Here an interval of only three or four millimeters separated the blue and red injection masses.

The dissection of this fish proved that both the red and the blue celloidin had entered the rectal prolongation of the cardinal sinus. The failure of the two masses actually to meet was doubtless caused by the inclusion between them of a quantity of gas for which there was no avenue of escape. The lateral vein received two trunks from the pelvic fin. The larger one of the two emerged from the fin dorsal to the end of the girdle and

just posterior to the iliac process. The smaller vein left the fin on the anterior side of the first or pre-axial fin-ray.

II. Raia erinacea: young male.

1. Renal portal system injected, *via* the caudal vein, with blue celloidin.

A small amount of the celloidin appeared in the cardinal sinus.

2. Left lateral vein injected posteriorly with red celloidin.

The mass did not appear on the rectum.

During the progress of the injection the posterior margin of the left pelvic fin was cut away. The red celloidin escaped from a small vessel lying along the median edge of the clasper.

In the dissection of this fish the lateral vein was traced to the wall of the cloaca, where it was lost in fine branches. A large vein from the pelvic fin was found opening into the lateral vein at a point dorsal to the girdle and just posterior to its iliac process.

III. Raia erinacea: female.

1. Renal portal system injected, *via* the caudal vein, with blue (raw) starch.

The starch mass did not pass into the cardinal sinus.

2. Left lateral vein injected posteriorly with red celloidin.

A fine anastomosing network on the cloaca and rectum was injected, as in I.

The left pelvic fin was cut, as in II. There was slight evidence of the red celloidin at the cut surface.

By dissection, the lateral vein was traced back along the pelvic region of the abdominal wall and onto the lateral wall of the cloaca along which it ran, giving off numerous branches and rapidly diminishing in caliber, to a point about 15 millimeters posterior to the rectal gland, where it became completely lost in a fine network.

The lateral vein was found to receive from the pelvic fin a fairly large trunk which emerged from the fin on the anterior side of the first or pre-axial fin-ray.

IV. Raia erinacea: large male.

1. Blue starch injected into the caudal vein.

The blue starch appeared in the left lateral vein and filled the greater portion of it, together with some of its branches from the body wall.

Dissection of the animal showed that the renal portal system was fully injected. The position and connections of the vein which put into direct communication the renal portal and lateral systems are represented in Figure 2. Lying transversely on the left dorsal body wall was found a large vein (Fig. 2, *x*) opening at

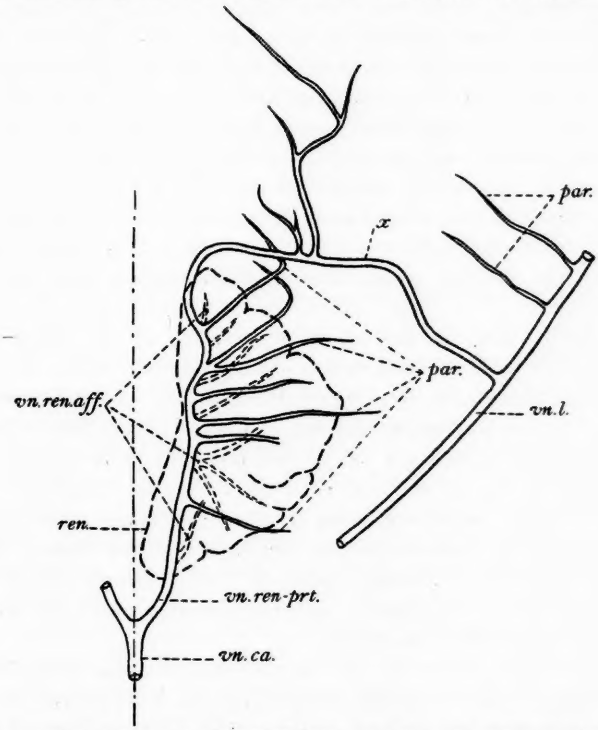

FIG. 2.— Showing the connection found in Case IV between the renal portal system and the lateral vein. *par.*, parietal branches of the renal portal and lateral veins; *ren.*, kidney; *vn. ca.*, caudal vein; *vn. l.*, lateral vein; *vn. ren. aff.*, afferent renal veins; *vn. ren-prt.*, renal portal vein; *x*, vein connecting renal portal and lateral veins.

its one end into the left lateral vein, and at its other into a large anterior renal portal component, which was virtually a direct continuation of the renal portal vein itself forward on the dorsal body wall. Jourdain ('59) describes a similar anterior component of the renal portal system.

The extreme posterior end of the lateral vein was found to be not injected.

V. *Raia lævis : very large female.*

1. Renal portal system injected, *via* the caudal vein, with blue starch.

2. Left lateral vein injected posteriorly with red celloidin.

A particularly full injection of the branches of the posterior part of the lateral vein was secured. The mass appeared on the walls of the cloaca and rectum in an anastomosing network of fine vessels, which were traceable along the rectum to a region about one centimeter anterior to the duct of the rectal gland. The mass was seen also in small vessels on the ventral margin of the mesorectum, and *a considerable quantity of it passed through the rectal extension of the cardinal sinus into the main part of that sinus.*

The left pelvic fin was cut, as in preceding cases, and the red mass escaped from small vessels along its median edge.

The dissection of this animal demonstrated clearly a connection between the venous network on the rectum and the cardinal sinus. The lateral vein was traced forward a short distance on the side of the rectum and there broke up into fine branches which anastomosed with vessels of the network. Along the margin of the mesorectum, in the region of the base of the rectal gland, several small vessels resolved themselves out of the network and communicated with the posterior end of the rectal extension of the cardinal sinus.

From the pelvic fin the lateral vein received two large trunks and one very small vein (see Fig. 4). The largest trunk emerged from the fin just posterior to the iliac process of the girdle, corresponding, therefore, with the one vein found in II and with the posterior one of the two veins found in I. This

trunk, from its position and size, is doubtless entitled to the name, *femoral vein*. It receives one large branch from the median side of the basipterygium. The remainder of its branches are distributed upon the external side of the basipterygium, collecting the blood from much the greater portion of the fin. A second and considerably smaller vein emerged from the fin on the anterior side of the pre-axial fin-ray, corresponding with the vein found in III and with the anterior one of the two veins found in I. The branches of this vein were distributed around the large pre-axial fin-ray, the main axis of the vein lying along the anterior side of the ray.

The third one of the three veins mentioned as entering the lateral vein from the pelvic fin was a very small vessel which lay just anterior to the iliac process of the girdle.

VI. Raia erinacea: small female.

1. Renal portal system injected, *via* the caudal vein, with blue celloidin.

A trace of the celloidin appeared in the right postcardinal vein.

2. Right lateral vein injected posteriorly with red celloidin.

The mass entered a fine network of vessels on the cloaca and rectum, passed through minute vessels lying along the ventral margin of the mesorectum, and a small quantity of it collected in the rectal extension of the cardinal sinus.

By dissection, the lateral vein was traced up to the wall of the cloaca (see Fig. 3), where, at a point nearly in the same transverse plane with the anterior end of the external cloacal aperture, it divided into two branches. Each of these immediately broke up into fine branches which anastomosed with vessels of the network. On the dorsal wall of the rectum and just behind the rectal gland, the network resolved itself into a system of fine vessels (Fig. 3, A and B, *vn.*) lying nearly parallel with one another, frequently anastomosing, and converging forward into fewer and larger vessels in such a way that there was a gradual transition from the rectal network into the single very narrow lumen of the posterior tip of the cardinal sinus.

No veins from the pelvic fin were injected.

Examination of a number of skates which had been injected (by students) with starch or a starch-gelatin mixture (see Rand, :05) brought to light several animals in which the rectal venous network had been more or less completely filled from the cardinal sinus. In these cases, the lateral vein had been injected forward, but not backward. The cardinal sinus had

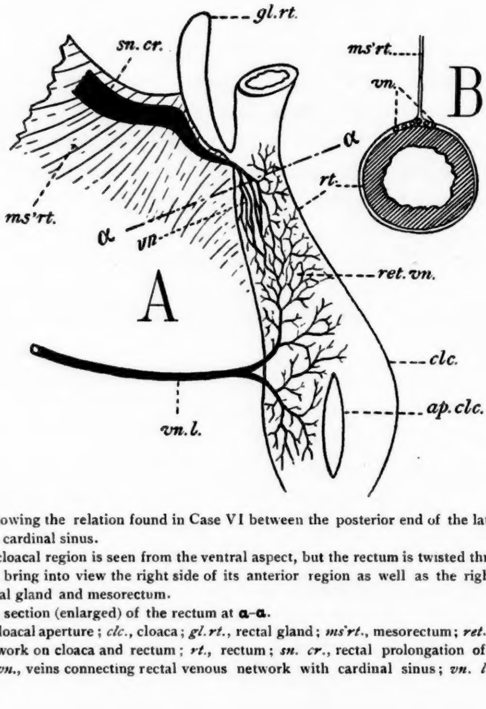

FIG. 3.—Showing the relation found in Case VI between the posterior end of the lateral vein and the cardinal sinus.

A. The cloacal region is seen from the ventral aspect, but the rectum is twisted through 90° so as to bring into view the right side of its anterior region as well as the right side of the rectal gland and mesorectum.

B. Cross section (enlarged) of the rectum at **a–a**.

ap. clc., cloacal aperture; *clc.*, cloaca; *gl. rt.*, rectal gland; *ms'rt.*, mesorectum; *ret. vn.*, venous network on cloaca and rectum; *rt.*, rectum; *sn. cr.*, rectal prolongation of cardinal sinus; *vn.*, veins connecting rectal venous network with cardinal sinus; *vn. l.*, lateral vein.

filled from the precaval (Cuvierian) sinus and the mass had made its way back through the rectal extension of the cardinal sinus into the rectal network. This network, therefore, may be injected either from behind, by way of the lateral vein, or from before, by way of the cardinal sinus. Figure 4 shows the lateral vein in its entire extent, with its connections as found in our injected skates.

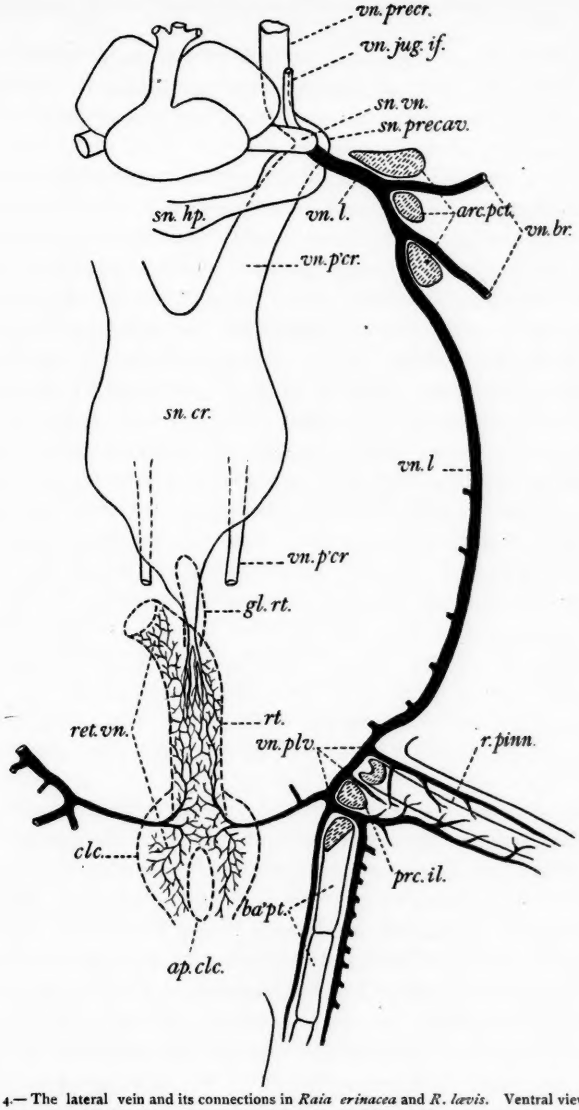

FIG. 4.— The lateral vein and its connections in *Raia erinacea* and *R. lævis*. Ventral view. *arc. pct.*, pectoral girdle ; *ap. clc.*, cloacal aperture ; *ba'pt.*, basipterygium ; *clc.*, cloaca ; *gl. rt.*, rectal gland ; *prc. il.*, iliac process of pelvic girdle ; *r. pinn.*, pre-axial ray of pelvic fin ; *ret. vn.*, venous network on cloaca and rectum ; *rt.*, rectum ; *sn. cr.*, cardinal sinus ; *sn. hp.*, hepatic sinus ; *sn. precav.*, precaval sinus ; *sn. vn.*, venous sinus ; *vn. br.*, brachial veins ; *vn. jug. if.*, inferior jugular vein ; *vn. l.*, lateral vein ; *vn. p'cr.*, postcardinal vein ; *vn. plv.*, veins from pelvic fin ; *vn. precr.*, precardinal vein.

Do the veins of the rectal network communicate directly with the posterior factors of the hepatic portal system, as stated by Hochstetter for Squalus, and as thought probable by Parker ('81) for *Raia nasuta*?

Good starch injections of the intestinal veins often result in the demonstration of a venous network on the rectum in the region of the base of the rectal gland. The network which has been demonstrated by injection from the lateral vein often extends into the same region. It is improbable that there should be two distinct and non-communicating sets of veins in this same region of the intestine. In one case (I) the red celloidin passed through the venous network on the rectum and appeared in a very small vessel which was identified, with a fair degree of certainty, as the extreme posterior end of the mesenteric or dorsal intestinal vein, the hindmost trunk of the hepatic portal system. The failure of the celloidin to flow freely through the network into the hepatic portal vessels, granting that the connection exists, might well be due to the solidifying of the celloidin in the fine vessels of the network as the result of contact with moisture. The senior author has seen injected skates in which a yellow starch mass, injected backward into the mesenteric vein, appeared actually to meet, in the region of the rectal gland, a blue starch mass which had made its way into the rectal network *via* the rectal extension of the cardinal sinus, the two masses clearly lying in the same vessels.

With a view to getting more conclusive evidence as to the relation between the rectal network and the hepatic portal system, the senior author secured some fresh skates of the common species, *R. erinacea* (at Woods Hole, Massachusetts, through courtesy of officials of the United States Bureau of Fisheries and of the Marine Biological Laboratory), and made injections in the following way. A fluid consisting for the most part of water, but containing a small amount of glycerin and colored with finely pulverized insoluble Prussian blue, was injected backward into one of the lateral veins. The rectal network immediately became very fully injected and the blue fluid passed along the mesorectum into the cardinal sinus, in the manner already described. Then a ligature, which had previously been

passed around the narrow posterior end of the rectal extension of the cardinal sinus, was tightened so that further flow of the fluid into the cardinal sinus was prevented. A very light pressure on the syringe was maintained, with the result that the blue fluid appeared in the posterior region of the mesenteric vein and in its posterior branches, whence it passed forward, filling most of the veins on the intestine. The intestinal arteries were then injected, *via* the anterior mesenteric artery, with a fluid similar to that used for the veins, but colored with pulverized carmine. There was no interference or mingling of the blue and red fluids on the intestine, nor was there any evidence that the blue fluid had passed through capillaries into arteries.

The injection of the Prussian blue fluid backward into the mesenteric vein gave similar proof of the continuity of the portal veins and the rectal network. The fluid appeared in extremely fine vessels over the entire intestinal wall and, passing through the rectal network, entered the cardinal sinus and both lateral veins.

To summarize, in *Raia erinacea* and *R. lævis* (see the diagram, Fig. 5): —

(1) There are no veins similar to the large ilio-hæmorrhoidal veins described by Parker for *R. nasuta*.

(2) The two lateral veins have a common origin in a close network of fine vessels distributed over the walls of the rectum and cloaca.

(3) This venous network communicates with the cardinal sinus by means of small vessels lying along the ventral margin of the mesorectum, in the region of its attachment to the rectal gland.

(4) The vessels of the rectal network communicate with the posterior factors of the hepatic portal system as stated by Hochstetter and as thought probable by Parker.

(5) The lateral vein receives the blood from the pelvic fin, there being, in addition to the chief femoral vein, one or two smaller vessels from the fin which open into the lateral vein independently.

The relations of the lateral veins to other parts of the venous system are, therefore, substantially as described by Hochstetter

for selachians in general, except for the connection with the cardinal sinus *via* the cloaco-rectal network.

It is probable that the flow of blood throughout the entire length of the lateral vein is from the cloaco-rectal network and toward the precaval sinus. The steady increase in the diameter of the vein as it leaves the network and curves along the pelvic region points toward this view, as does also the presence, in the pelvic region of the vein, of valves placed so as to impede a posterior flow. The cloaco-rectal network is doubtless an indifferent region as regards flow, the blood passing from it into either the hepatic portal system, the cardinal system, or the

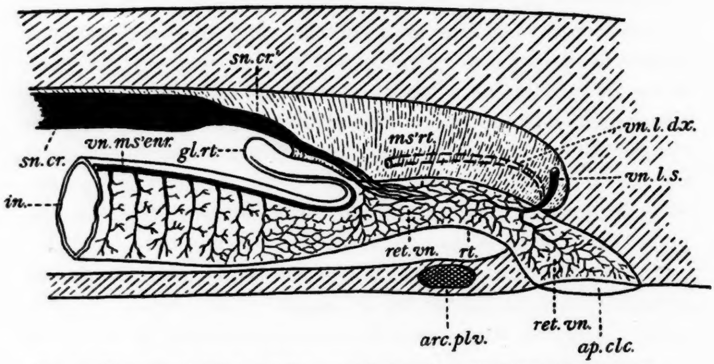

FIG. 5 — Diagrammatic side view of cloaco-rectal region, showing relations of lateral veins, cardinal sinus, and mesenteric vein. *ap. clc.*, cloacal aperture ; *arc. plv.*, pelvic girdle ; *gl. rt.*, rectal gland ; *in.*, intestine ; *ms'rt.*, mesorectum ; *ret. vn.*, venous network on cloaca and rectum ; *rt.*, rectum ; *sn. cr.*, cardinal sinus ; *sn. cr'.*, rectal prolongation of cardinal sinus ; *vn. l. dx* , right lateral vein ; *vn. l. s.*, left lateral vein ; *vn. ms'enr.*, mesenteric vein.

lateral veins. The blood from both the pectoral and the pelvic fin of one side, therefore, passes to the heart by the same vein.

In two of the dissections made by Mr. Ulrich a suggestive condition was found. The lateral vein, steadily diminishing in caliber, was traced to the wall of the rectum where, at first glance, one would say that it became lost in the network. But close inspection revealed an extremely fine vessel which was virtually the continuation of the lateral vein along the side of the rectum. This fine vessel maintained a fairly straight course through the midst of the rectal network, of which, by reason of

frequent anastomoses, it was really a part, and could be traced forward to the cardinal sinus, except for one or two interruptions where it completely lost itself by branching into the network. If the relatively short gaps in the continuity of this fine vessel were filled in and if the continuous vein thus formed should become nearly as large as the largest part of the lateral vein, the result would be the ilio-hæmorrhoidal vein described by Parker. The condition just described suggests the presence of either an incipient or a rudimentary "ilio-hæmorrhoidal" connection between lateral vein and cardinal sinus. An examination of embryonic stages might yield further information.

The direct connection existing in one case (IV, p. 355) between the renal portal system and the lateral vein is due apparently to the anastomosis of a parietal factor of the renal portal system and one of the parietal branches of the lateral vein. Normally these two sets of veins on the dorsal wall of the abdominal cavity come into close relation at their initial ends. This unusual relation of the lateral vein to the renal portal system is of no great importance in itself, but it is suggestive in connection with the theory that the lateral veins of elasmobranchs are represented in higher vertebrates by the abdominal vein. Just as the two lateral veins in the elasmobranch collect the blood from the walls of the cloaca and from the pelvic fins, so, in the urodele amphibian, the abdominal vein receives the veins from the urinary bladder (which is a derivative of the cloaca), and the two posterior components of the abdominal vein receive the veins from the hind legs. The chief difference is that, in the elasmobranch, the lateral system has no direct connection with the renal portal system, while in the amphibian each of the two posterior components of the abdominal vein is directly connected with the corresponding afferent renal portal vein. Development, as is well known, affords some evidence in favor of the homology. In consequence of the slight abnormality described above, there occurs in the veins on one side of the body in the kidney region of a skate an arrangement similar in all essential respects to that in amphibians. Such an anastomosis of a lateral and a renal portal component occurring on both sides of an elasmobranch and in the posterior region of the

kidneys would yield a condition precisely like that seen in the relations of the abdominal, iliac, and renal portal veins of a urodele. This abnormal skate serves at least to suggest a possible way in which one of the differences in the arrangement of the veins of elasmobranch and amphibian may have arisen.

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CONTRIBUTIONS FROM THE ZOÖLOGICAL LABORATORY OF THE MUSEUM OF COMPARATIVE ZOÖLOGY AT HARVARD COLLEGE. E. L. MARK, DIRECTOR. No. 166.

THE SKATE AS A SUBJECT FOR CLASSES IN COMPARATIVE ANATOMY; INJECTION METHODS.

HERBERT W. RAND.

THE selection and obtaining of material for the laboratory work of classes in zoölogy, and the best methods of treating that material, are matters of considerable importance to those having such work in charge. My use of the skate for several years past has impressed me with the belief that it is, in some respects, peculiarly adapted for use in the laboratory work of classes in the comparative anatomy of vertebrates. If I am not mistaken, the advantages of the skate for this purpose and the practicability of using it are not always fully realized, especially by teachers who are situated at some distance from the sea. In view of this fact, I think it worth while to call attention to certain points wherein the skate seems to me to be a superior subject for laboratory work. In addition, I shall consider methods of injecting the circulatory system of this fish.

If a student in comparative anatomy is to study a fish as a representative of the class, obviously it should be one which exhibits as nearly as possible primitive vertebrate conditions, — therefore an elasmobranch. If an amphibian is to follow the fish, it should, of course, be one of the tailed amphibians rather than the highly specialized frog. The elasmobranch, in its general anatomy, is much more directly and closely comparable with the urodele than is any teleost. To start a student in vertebrate anatomy on the dissection of a teleost and to follow that with the frog, as a representative of Amphibia, is as poor a program as could be arranged, if it is the intention that he should

see for himself something of the main course in the evolution of the structure of higher vertebrates. The study of types situated near the main line of vertebrate descent is to be preferred to the study of extremes of specialization. It seems to me to be questionable wisdom to let enthusiasm for local fauna lead to the selection of a teleost, for class study, provided that marine material is obtainable, and provided further that only one representative of Pisces can be studied.

Among the elasmobranchs, the sharks depart less conspicuously from primitive conditions than the rays and therefore, theoretically, the dogfishes are to be preferred to the skates for general laboratory purposes. The dorso-ventral flattening of the skate, however, gives it a certain superiority as a subject for dissection. As a result of the flattening, most of the organs of the animal are much more easily accessible than they are in the dogfish. This advantage is of particular importance when it comes to the injection and dissection of the blood-vessels.

The abdominal cavity of the skate is completely exposed with a minimum of cutting. This cavity is a broad and very shallow one so that, its ventral wall having been removed, a slight displacing of viscera brings all its organs immediately into view and renders its chief blood-vessels very easy of access.

It is a consideration of no small moment that the skate, during injecting and dissecting operations, lies in the position most favorable for work — that is, flat on its back — without any special device for holding it there, while it is not always easy to support a dogfish in a desired position.

In the dissecting and study of the circulatory organs, the flattening of the skate is especially advantageous, because, one might say, it tends toward the projecting of the blood-vessels into one plane, resulting in an almost diagrammatic arrangement of them.

A practical point which will often lead to the selection of the skate, if elasmobranch material is to be used, is the fact that skates can be obtained during a large part of the year when dogfish can not. Mr. F. T. Lane, of Rockport, Massachusetts, in response to my inquiry, writes me that he can catch skates off Cape Ann at any time of the year, except during storms,

whereas dogfish can be taken in abundance only during June, July, and August, and sometimes in September. No dogfish are to be caught, he says, from the first of December to the first of May. Also in reply to inquiries of mine, Dr. F. B. Sumner, director of the laboratory of the Woods Hole station of the United States Bureau of Fisheries, states (largely, he says, on the authority of Mr. Vinal Edwards, collector for the station) that skates can be taken in the vicinity of Woods Hole at any time of year except in January, February, and March. Smooth dogfish (*Mustelus canis*) "can be taken in considerable numbers from the latter part of June till November first, being most abundant soon after their appearance late in June," while spiny dogfish (*Squalus acanthias*) are abundant only in May and early June. Neither species of dogfish can be taken in that region from the middle of November until the first of May. Similar statements as to the occurrence of dogfish and skates are made by Dr. Hugh M. Smith ('98) in his list of "The Fishes Found in the Vicinity of Woods Hole."

It appears from the foregoing statements that, so far as the New England coast is concerned, fresh skates, suitable for injection purposes, may be had throughout the greater part of the year, or possibly throughout the whole year, while fresh dogfish can be obtained during not more than five, or possibly six, months of the year. Furthermore, the dogfish are most abundant and most easily taken during the summer months when they are least wanted for laboratory purposes in schools and colleges, except as they may be preserved then and stored for future use. To be sure, dogfish may be collected and injected in the summer and preserved for use later in the year. But, to my mind, there are serious objections to giving a student his animals already injected. He should make his own injections. The injecting of the animal which he is to dissect gives the student information which he will not get so well in any other way, besides being a valuable means of developing skill in operating.

As regards the practicability of shipping fresh elasmobranch material to points distant from the coast, there is no sufficient reason why, in these days of rapid transportation, such material

cannot be had by almost any institution in the country, however remote from the coast. Fish properly packed, so as to secure coolness and freedom from too great pressure, will endure well several days' transportation, especially in the cooler seasons of the year. Skates which are intended for injecting for non-histological purposes are not injured by freezing, provided that they are not exposed to alternate freezing and thawing.

A point of minor importance is the fact that it is easier to secure good preservation of skates than of dogfish. The flattening of the skate's body facilitates the penetration of the preserving fluid to the deep organs. Furthermore, to get sexually mature animals, it is necessary to use dogfish of such large size that the preservation and storing of material for a large class become a serious problem. The same number of small sexually mature skates makes a much less bulky mass of material.

The objection that the skate is a highly specialized elasmobranch does not apply, to any great extent, to its internal anatomy. The specialization involves chiefly the general form of the body. The skeleton and muscles are the systems most affected. The remaining organs undergo relatively unimportant changes in position incident to the flattening of the body. In their essential morphological characters and relations they are closely comparable to those of the shark-like elasmobranchs. From a practical point of view, it might be said that the specialization of the skate is in the direction of adaptation for laboratory purposes.

The plan which has been followed for several years past in the laboratory of vertebrate comparative anatomy at Harvard University seems to me to be an excellent one. The student first makes a general dissection of the dogfish, exclusive of the blood vessels, then injects a fresh skate for the study of the circulatory system. By this arrangement he becomes familiar with the anatomy of the more primitive elasmobranch and studies a typical elasmobranch circulatory system under conditions far more favorable than those offered by the dogfish. At the same time, his familiarity with the dogfish enables him to detect the essential elasmobranch characteristics in the skate and to comprehend the nature of its specialization. Thus, he is

given an opportunity for observing, in an appreciative way, a remarkable case of modification of form. If the student's main work is on the skate, he should at least be given an opportunity to compare skate and dogfish far enough to make clear to him the character of the skate's departure from the more primitive conditions.

Injection Methods.

Injection of the Veins of the Skate.— What I have to say about the injection of the veins of the skate is with special reference to the best method by which this operation may be performed by students who have had little or no experience in such work. It is assumed that the injecting is to be done by means of an ordinary hand syringe.

A complete injection of the systemic veins of the skate is difficult to obtain, even under the most favorable circumstances, partly because the veins are well provided with valves which impede the flow of the injection mass in a direction the reverse of that of the blood-flow, and partly because of the presence of large thin-walled sinuses, which are likely to rupture before the injection mass can be forced into the smaller vessels and those more remote from the point of injection.

The vessels most accessible for the injection of the systemic veins are the postcardinal veins in their renal region, the venous sinus, and the lateral veins. Parker ('95) recommends introducing the injection mass at the venous sinus, the flow of the mass being directed backwards, or away from the heart. An injection directed forward into the hinder or renal part of one of the postcardinal veins has been employed with more or less success. In my opinion, however, injection by way of one of the lateral veins possesses certain advantages over either of the other methods.

The injection of the renal division of the postcardinal vein is objectionable for two reasons. In the first place, it is very difficult to dissect out the vessel. It lies under the peritoneum in a loose mass of connective tissue, and unless the operator is fairly skillful, the cannula is quite likely to be pushed into lymph

spaces or into any opening other than the proper one. In the second place, an injection mass entering by way of the renal end of the postcardinal vein passes directly to the great thin-walled cardinal sinus. No other veins can fill until the pressure in the cardinal sinus has increased sufficiently to force the mass on into the smaller and more remote spaces. This involves great danger of bursting the wall of the cardinal sinus. In practice, the danger may be lessened by exerting external pressure upon the sinus, either with the hand or by other means, so as to prevent its becoming distended to its utmost capacity.

The venous sinus is a point more favorable for injection than the postcardinal vein, so far as the filling of the vessels is concerned. If the injection mass is directed backward into one arm of the venous sinus, the initial pressure of the fluid is exerted almost directly at the ends of the several main venous trunks which, other things being equal, stand equal chances of filling. In practice, however, this method has been found objectionable when attempted by an unskillful student (and since the fish is usually the first animal injected by a student in comparative anatomy, he is quite likely to be unskillful through lack of experience). The venous sinus is not very favorably situated for the injecting operation. Great care is required lest the cannula be pushed against the delicate wall of the sinus so as to rupture it. Poor judgment in controlling the pressure on the syringe results in the bursting of the sinus, and often the thin-walled auricle is injured in the course of the operation. In the case of a preparation for demonstration or museum purposes, the cutting of the venous sinus is, in itself, objectionable.

The difficulties which are met in the injecting of the postcardinal vein or venous sinus are largely or wholly avoided by the use of the lateral vein. The lateral vein is a large vessel extending along the entire length of the side wall of the abdominal cavity and lying just beneath the peritoneum. It is conspicuous in skates which have been dead not more than a day or two, because of the blood contained in it. It is not necessary, as in the case of the renal vein, to dissect out the vessel for injection. The following method will be found practicable.

Open the abdominal cavity and note the position of the lateral

veins. Then, at a region about midway of the length of one lateral vein, and in a plane transverse to the long axis of the fish, make an incision into the muscle of the lateral wall of the abdominal cavity, carrying the incision across the lateral vein and somewhat dorsal to it (see the figure, page 377). The incision must be deep enough to admit of pressing apart the masses of muscle either side of the cut in such a way as to make easily accessible the two cut ends of the lateral vein. Immediately, then, before the loss of the blood contained in the vein shall have made it difficult to see the vessel, thrust a probe or a coarse bristle forward into the cut end of its anterior division and another backward into its posterior division. A mass which "sets" quickly may be injected without tying the cannula into the vein. For this purpose it is desirable to use a cannula of a size sufficient nearly to fill the lumen of the vein. Such a cannula, with the injection apparatus attached, may be inserted successively into the two cut ends of the vein and held firmly in place with the fingers during the process of injecting. If it is desired to tie the cannula in place, the muscle may be cut away from around the cut end of the vein so as to leave about one centimeter in length of the vessel projecting, with more or less tissue attached to it. A ligature may then be passed around this small projecting mass of tissue, including the vein, and, the cannula having been inserted, the ligature is tightened upon it.

The fluid which is injected into the anterior division of the lateral vein passes directly to the corresponding precaval (Cuvierian) sinus, whence it may pass into all the chief venous trunks of that side except as impeded by valves. It passes also, by way of the venous sinus, directly across to the opposite precaval sinus, whence it may enter the vessels of that side of the body. The cardinal and hepatic sinuses afford other, but less direct, routes for the passage of the fluid from one side to the other. In practice, this method usually results in the filling of both lateral veins and at least the proximal ends of the several brachial trunks. The mass fills also the postcardinal veins, including their posterior inosculation, the hepatic sinus and veins, the cardinal sinus, and the proximal ends of the inferior jugulars.

The precardinal veins, however, are rarely injected by this or by any other method, except that of direct injection of each precardinal from its anterior end, — an operation which is not practicable for anyone who is not familiar with the position of the vein.

The filling of the cavities of the heart may be prevented or controlled by means of ligatures tied around the heart in the regions of the sinu-auricular and auriculo-ventricular apertures.

The injection into the posterior division of the lateral vein fills the posterior connections of that vein, including the veins from the pelvic fin (see Rand and Ulrich, :05).

In brief, the advantages of injection *via* the lateral vein are as follows: (1) the lateral vein is a sufficiently large vessel and most easy of access; (2) its preparation for injection is a simple operation, requiring no nice dissection nor other delicate technique; (3) it is a relatively narrow and strong-walled vein, not easily broken by the point of a cannula, and capable of withstanding the initial pressure of the injection; (4) it conveys the mass first to the precaval sinus, whence the chief vessels may fill; (5) the weak-walled cardinal sinus is remote from the point of injection; (6) maximum filling of the systemic veins is secured by a single operation.

An injection of the renal portal system is secured easily by cutting across the tail at least four or five centimeters back of the cloacal aperture and injecting forward into the caudal vein. A taper-pointed glass cannula may be inserted carefully into the cut end of the vessel and pushed in until the end of the vein is tightly closed. During the progress of the injection the cannula must be held firmly in place. When the cannula is withdrawn, the escape of the fluid may be prevented by jamming a bit of cotton into the end of the vein.

The hepatic portal system is best injected through the mesenteric vein. To secure a full injection upon the intestine the vein must be injected backward as well as forward. Parker ('95, p. 48) injects the duodenal vein, thus getting a complete injection at one operation. This is, indeed, an advantage. But, in small skates, the greater size of the mesenteric vein, and the fact that it is so much more accessible than the duodenal vein,

make the two-way injection of it usually less difficult to the student than the single injection of the duodenal vein.

Injection Masses. — For the injection of the vessels of the skate I have used an injection mass which is merely a slight modification of well known masses, but one which may be found to possess peculiar virtues for certain special purposes. Among the injection masses suitable for purposes of gross dissection, the cold or unboiled starch mass of Pansch ('77, '81; see Whitman, '85, pp. 223–225) is doubtless best for general laboratory use, especially where, in the case of a large class, many injections must be made rapidly. It is inexpensive, easy to use, and gives results satisfactory for temporary demonstrations. It is, however, not perfectly adapted for permanent demonstrations or museum preparations, owing to the fact that it does not "set" or harden. The particles of starch remain in a discrete condition so that, in the event of any injury to the wall of an injected vessel, the mass may leak out and discolor the surrounding tissue. The starch mass is poorly adapted for the injection of the venous system of the skate because it is practically impossible to dissect the thin-walled and irregularly shaped vessels without an occasional slight injury, which gives rise to annoying leakage of the mass.

Recently I had need of a mass which should acquire, after injection, a fairly stiff consistency without becoming brittle, which should not pass through capillaries, and which should be convenient to use. Some modification of the gelatin method seemed most likely to satisfy these conditions. A gelatin mass with the coloring matter in solution, as ordinarily prepared, is designed to pass capillaries. After some unsatisfactory experiments with gelatin colored by means of pulverized carmine or insoluble Prussian blue in suspension, it was suggested by Mr. J. A. Long, who was working with me, that starch be mixed with the melted gelatin to prevent its passing into the capillary vessels. We had at hand a supply of the unboiled starch mixture in several colors. The method which we used with success at that time consisted in stirring into the melted gelatin about one fourth its volume of the thick starch mass, which always settles to the bottom of a jar containing the raw starch mixture.

Thus, the starch and the color were added both at once. In the absence of the prepared starch mixture, a similar result may be attained as follows.

Mix together some of the grocer's pulverized cornstarch and about one seventh its volume of a suitable finely powdered coloring matter (carmine, insoluble Prussian blue, chrome yellow, chrome green). Add a little cold water to the mixture and convert it into a thick paste. Into the melted gelatin stir one third or one fourth its volume of the colored starch paste. The proportions of the mixture may be varied, as occasions demand. I have found the following formula convenient: —

Melted gelatin	75 volumes.
Dry cornstarch	22 "
Dry color	3 "

For non-histological purposes it is, of course, unnecessary to use the finer grades of gelatin, such as photographic gelatin. Any ordinary culinary gelatin serves equally well, besides being always easily obtainable and less expensive. A mass of good stiffness for injection purposes is obtained by using 1 gram of dry gelatin to every 7 or 8 ccm. of water. If the vessels to be injected contain much blood, the gelatin solution must be of such strength that the mingling of the blood with it will not prevent the hardening of the mass. It is better not to inject the veins of a skate immediately after the death of the animal, for then the sinuses contain a large quantity of blood. If the fish is kept in a cool place for about two days after death, the greater part of the blood will have disappeared from the vessels. At the same time, the walls of the vessels will have relaxed so that the injection is more likely to pass into the smaller vessels. This latter consideration is of more importance with reference to the arteries than to the veins.

As regards the convenience of the starch-gelatin method, the warming of the animal, preliminary to the injection, is unnecessary. The chief difficulty, therefore, which attends the gelatin method as ordinarily used for histological purposes, is obviated. I have obtained good starch-gelatin injections of the entire circulatory system of the skate, working in a room at

ordinary temperature (20° C.) without warming the animal above the temperature of the room. The melted gelatin was slightly superheated, and the heavy brass syringe, with rubber tube and cannula, was heated by immersing in hot water to a temperature about as high as consistent with comfort in handling. By these means, the starch-gelatin was introduced into the blood-vessels at a temperature considerably above its solidifying point. The warm fluid penetrates into the smaller and remote vessels before becoming cooled sufficiently to harden, giving quite as full an injection of the finer vessels as the cold starch mass ever does.

The skates which I have injected with starch-gelatin were immersed, immediately after injection, in three or four percent formalin, which, having been freshly prepared with tap water, was considerably cooler than the room temperature. The starch-gelatin promptly solidified into a firm mass having the consistency characteristic of stiff gelatin.

The starch-gelatin method described above gives results entirely satisfactory for purposes of gross dissection. The method may be used under any conditions where the unboiled starch mass might be used, but where a mass of the consistency of gelatin is to be preferred. The advantage of the starch-gelatin as compared with the raw starch lies in the fact that the mixture "sets" and, therefore, will not escape, however much the vessels may be cut. The advantage, for the purposes mentioned, of the mixture as compared with pure gelatin is in the fact that the starch causes the mass to stop at capillaries, thus preventing danger of the injection passing from one set of vessels into another. Finally, the method is not a particularly troublesome one, since the warming of the animal itself — usually the greatest inconvenience attending the use of any warm injection mass — may be omitted. The superiority of the starch-gelatin is most marked in the injecting of a blood-system containing large thin-walled sinuses, as in the case of the venous system of the skate. Its advantages over plaster of Paris for this purpose, are obvious and it is scarcely more troublesome to use.

The injection of the arteries of the skate is a comparatively simple matter. The afferent branchial vessels may be injected

through the arterial cone, as directed by Parker ('95, p. 48). For the systemic arteries, Parker makes a single injection at the duodenal artery. But, unless one is dealing with a large skate, I have found it better to inject the anterior mesenteric artery (see Fig. 1), in spite of the fact that it is necessary to inject it backward (to secure an injection upon the intestine) as well as forward. The greater size of the anterior mesenteric artery and its accessibility, lying, as it does, along the very edge of the mesentery, are advantages which more than offset the necessity of injecting it both ways. As for details, such as the form of the cannula and the manner of inserting it, I should consider Parker's method applicable to a very large fish only. The caliber of the anterior mesenteric artery in skates of small or medium size is such as to require the use of a cannula with a slender slightly tapering tip. By Parker's method, a cannula-full of air is injected into the vessel. To avoid this, the cannula should be attached to the syringe and filled with the fluid before being inserted into the vessel.

In the accompanying figure of the skate I have indicated the points at which the injections may best be made, to secure as nearly as possible a complete injection of the blood vessels in three colors. The mesenteric vessels are conveniently reached by turning the stomach forward (so that, as the fish is viewed from the ventral side, the dorsal aspect of the stomach is seen) and pulling the digestive tube over to the animal's right side in such a way as to stretch out flat the mesentery. The figure represents the digestive tube in this position.

The several injections may well be made according to the following plan. Whatever the order, the arteries should be injected before the veins.

ARTERIES.

1. *Arterial cone* ------ forward --- blue starch-gelatin or starch.
2. *Anterior mesenteric* forward --- red " " " "
3. " " backward - " " " " "

VEINS.

Hepatic Portal.

4. *Mesenteric* ------- forward --- yellow starch-gelatin or starch.
5. " ------- backward - " " " " "

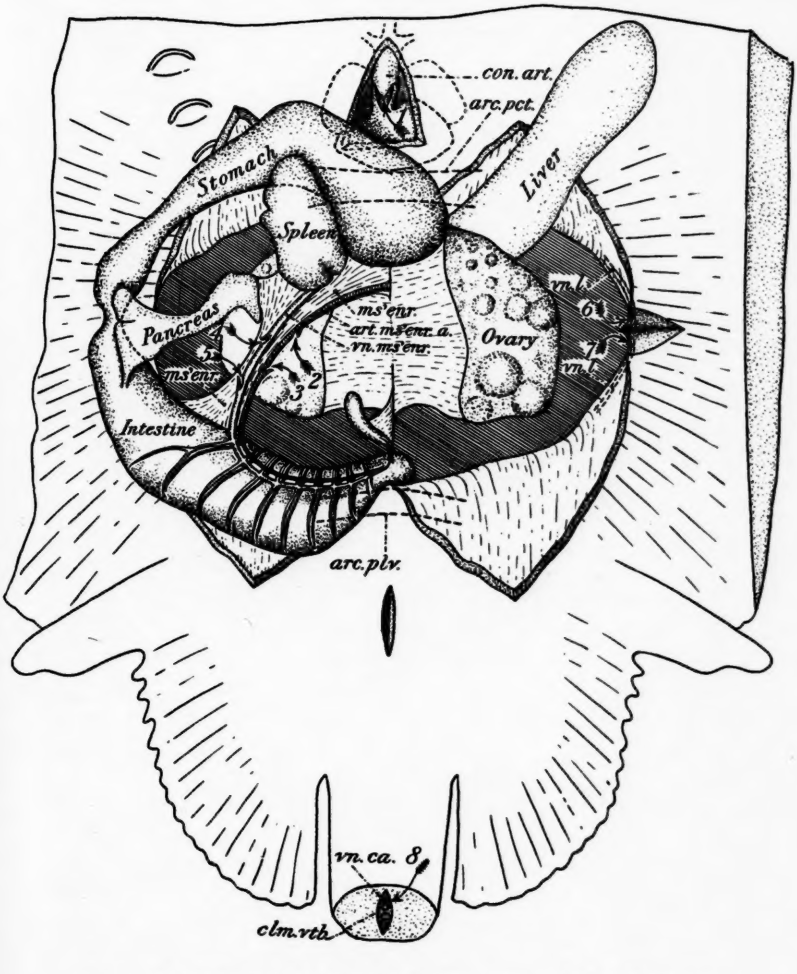

Fig. 1. — The injecting of the blood vessels of the skate. The arrows indicate the points at which the injections are to be made and the direction in which the cannula is to be inserted. The numbers attached to the arrows refer to the order of injecting given on page 376. *arc. pct.*, pectoral girdle; *arc. plv.*, pelvic girdle; *art. ms'enr. a.*, anterior mesenteric artery; *clm. vtb.*, vertebral column; *con. art.*, arterial cone; *ms'enr.*, mesentery; *vn. ca.*, caudal vein; *vn. l.*, lateral vein; *vn. ms'enr.*, mesenteric vein.

Systemic.
6. *Lateral* --------- forward --- blue starch-gelatin.
7. " ---------- backward - " " "
Renal Portal.
8. *Caudal* ---------- forward -- yellow starch-gelatin or starch.

If it is desired to use gelatin for only the systemic veins, where it is of greatest advantage, the arteries and the two portal systems may first be injected with cold starch and then the systemic veins with gelatin alone, for it is unnecessary to add starch to the gelatin to prevent its passing capillaries when all of the vessels beyond the system which is being injected are already filled.

Are so many as eight separate injections necessary? My experience has been that to decrease the number of operations is to increase their difficulty and to render the results less satisfactory. A mass injected into the systemic veins may pass through the heart into the afferent branchial vessels. Yet I have found it difficult to secure a full injection of the finer afferent vessels of the gills except by injecting directly into the ventral aorta itself. A perfectly fluid mass injected into the hepatic portal vessels or into the caudal vein may be made to fill the greater part of the venous system. But it is a great advantage in the dissection to have the hepatic portal and renal portal vessels distinguished from the systemic veins by a different color. The difference in color serves to emphasize to the mind of the student in a forcible way the nature of the relation between the portal systems and the systemic veins. The simplest way of securing the color difference is to inject each portal system separately. All the systemic arteries may be injected from the caudal artery at a single operation, but students succeed better with the two-way injection at the anterior mesenteric artery. In short, it is better to make eight easy operations than to make two or three of greater difficulty and less certainty.

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FOSSIL CRABS OF THE GAY HEAD MIOCENE.

JOSEPH A. CUSHMAN.

DURING the summers of 1903 and 1904 the writer made two trips to Gay Head for the purpose of obtaining fossils, especially those of the crabs so abundant there. The fossil crabs are found in the greensand layer in close relation to the so called "osseous conglomerate." At the northern end of the exposure, the crabs occur in a layer about six inches below the conglomerate, which is itself at this point a very narrow band. In this greensand layer which here is of a very dark, almost blackish green color when first dug out, the crabs lie in a natural position in the bed. That is, the crabs are in a position with their dorsal and ventral surfaces in the plane of the layer which contains them. As the edge of the layer is here exposed in the cliff and tilted at a very considerable angle, the edges of the crabs are struck in digging them out. They occur in very hard concretions, often entirely covered or as frequently, with a portion of the carapace or legs showing at the surface. The shelly portions of the crabs are decidedly black in color. The calcareous matter is still left, however, and entirely dissolves with effervescence in acid.

In another portion of the cliff, a short distance north of the lighthouse, the crab layer slopes in the opposite direction and is of a creamy white color. The crabs and the material in which they are imbedded are in consistency almost like cheese when dug out. This material is so soft that it can be easily cut with a knife. Upon exposure to the air the material quickly hardens and shrinks in drying, usually cracking considerably. The crab remains are here beautifully preserved in their details, the small papillæ on which the hairs are set being as perfect as they could have been in the living animal.

In certain cases in the larger concretions, there are obtained

remains which give a very good general idea of the crab as a whole. These larger concretions also have the various parts excellently preserved as will be noted in the description.

Dr. Edward Hitchcock was the first definitely to publish the occurrence of the crab remains at Gay Head. He spoke of them in his earlier reports on the geology of Massachusetts. In the Final Report of 1841, he speaks as follows: —

"Crustacea. In the green sand at Gay Head we meet with well-characterized specimens of the genus Cancer, although they are in general much broken, showing that they originally belonged to a formation which was abraded or destroyed anterior to the production of the green sand. The interior part of the specimen consisted of argillaceous matter, probably containing a large proportion of oxide of iron; but the covering of the animal still retains its black shining color, although apparently carbonaceous. The broken state of nearly all the specimens, renders it difficult to determine whether they belonged to more than one species, although they probably did: and for the same reason I have thought that drawings would not be of use."

In 1844, Sir Charles Lyell remarks at some length concerning the structure and fossils of the Gay Head exposure, both in the *Proceedings of the Geological Society of London* and in the *American Journal of Science*. In the latter (vol. 46, 1844, p. 319) he refers to the crab remains in the following words: —

"Crustacea. A species considered by Mr. Adam White as probably belonging to the genus Cyclograpsus, or the closely allied Sesarma of Say, and another decidedly a Gegarcinus."

In 1863, Dr. William Stimpson described *Archæoplax signifera* from the Gay Head greensand and mentioned that there is another species although he did not attempt to name it (*Boston Journ. Nat. Hist.*, vol. 7, pp. 583–589, pl. 12).

In 1900 (*Proc. Amer. Acad. Arts and Sci.*, vol. 36, no. 1, pp. 1–9, pls. 1–2), Professor Alpheus S. Packard describes a new fossil crab, *Cancer proavitus*, from Gay Head and gives a few notes and several photographs of *Archæoplax signifera* Stimpson.

Specimens representing the latter species were especially abundant in the material collected during the last two summers.

These show many points of structure not heretofore described. The material is in the museum of the Boston Society of Natural History, and is referred to by number. The material at the Museum of Comparative Zoölogy at Cambridge was also studied and is also referred to as well as one or two specimens in the teaching collection of the Paleontological Department of Harvard University.

Archæoplax signifera Simpson.

Archæoplax signifera Stimpson, *Boston Journ. Nat. Hist.*, vol. 7, no. 4, April, 1863, p. 584, pl. 12, figs. 1–4; Dall, *Amer. Journ. Sci.*, vol. 48, 1894, p. 297; Packard, *Proc. Amer. Acad. Arts and Sci.*, vol. 36, no. 1, July, 1900, p. 7, pl. 1, fig. 4, pl. 2, figs. 1–3.

Carapace. — In the specimens the length of the carapace varies from 1 to 2.5 inches, in greatest breadth from 1.2 to 2.75 inches, and in posterior breadth from 0.75 to 1.8 inches. The superior outline along the median antero-posterior line is decidedly curved as noted by Stimpson. This is shown in an outline side-view of a typical carapace (Pl. 1, Fig. 1). A similar view in the median line (Pl. 1, Fig. 2) shows at the slope at the sides and the depressions at each side of the median portion. The surface of the carapace is smooth, finely punctate or granular, the coarser granulation being in definite portions of the central region as well as of the anterior and lateral regions. The color pattern of the carapace is very well made out in several specimens. In the great majority of the specimens it is shown by a difference in smoothness and in luster of the surface, but may be seen as black markings against a dark gray background, as in Pl. 2, Fig. 3, or best of all on the under side of the upper surface as black markings on a very light brownish white background (Pl. 2, Fig. 4). Here the markings stand out with remarkable clearness. There is considerable variation in the markings of this species but all follow the same general pattern. The central lunate markings are important as a means of orienting any large or small part of a specimen of this species which

shows them. The variation in the central markings is shown in the two figures. In certain specimens examined the two sides of the same specimen varied much from each other.

As a whole the carapace is quadrangular, considerably broader in front than behind. The front angles have four teeth as described by Dr. Stimpson. Three of these are large, the first, second, and fourth, while the third is decidedly smaller. The orbits, as described, occupy about one third the breadth of the front of the carapace. The border is entire and raised, and is composed of crowded granules.

The front is nearly one fourth the width of the carapace and has a somewhat different form from that figured by Dr. Stimpson as a comparison of the figures will show. Excellent specimens of this part were obtained showing the complete form. There are two lateral lobes on the anterior border and a median lobe which is cut on the median line, making it emarginate. The front as a whole is bent downwards as shown in Pl. 1, Fig. 1. In the restoration it is drawn as though slightly raised to give its true shape (Pl. 1, Fig. 3).

In the specimens broken from large concretions the eyes have very frequently been excellently preserved. They have a prominent basal joint, with an expanded cylindrical outer portion of the shape shown in the figure. It seems strange that Dr. Stimpson did not obtain good specimens of the eyes for they have appeared very frequently in the collections of the last two summers.

Of the antennæ little was made out except their position which is but very slightly anterior to the base of the eyes. The bases of the antennæ appear as cross sections and as small bits now and then.

One specimen (Pl. 2, Fig. 5), showed the pair of antennules extending slightly beyond the front, but here again it was impossible to make out much more than their presence and position.

Turning to the ventral side, almost the entire features have now been made out and are included in the synthetic figure (Pl. 2, Fig. 6). The sternum is excellently preserved in a considerable number of specimens. A cast from the white layer showing all the minute tubercles was obtained (B. S. N. H. no. 12,977).

In drying, this specimen has cracked considerably. As a whole the sternum is nearly a plane surface except where it is hollowed in the center to receive the abdomen. The anterior portion, triangular in shape, is usually well separated from the rest. It varies considerably in size and shape. The main part of the large anterior plate is divided into three parts by a Y-shaped combination of sutures as seen in the figure. This is an incomplete division but the sutures are nearly always in evidence. As noted by Dr. Stimpson the "male genital tubercles" are found on the posterior margin of the second segment. These are situated just within the edge of the abdomen so that they are covered by it.

Dr. Stimpson found the abdomen of the male only, but in the collections of the past two years there are a few specimens of the abdomen of the female. The males appear to have been much more common. The male abdomen is approximately as figured by Dr. Stimpson, none of the segments being fused. A figure of the female abdomen is given (Pl. 2, Fig. 10). The third joint from the end is the widest, and there is an abrupt tapering from it toward either end. Of the abdominal appendages but one specimen, and that very incomplete, has appeared (Pl. 2, Fig. 11). This specimen indicates at least two pairs of these appendages.

One specimen (Pl. 2, Fig. 12) shows a cast of the outer maxilliped from which a fairly complete idea of these appendages may be obtained. Several other specimens show the basal joints in place and the minutely tuberculated surface (Pl. 2, Fig. 9).

The front legs are shown in a number of specimens, the basal and outer joints being those most frequently preserved. The teeth on two of the joints as figured by Dr. Stimpson, were not made out. The chelæ have a series of alternating teeth alike in both the left and the right sides. The various joints were more or less ornamented with a color pattern, portions of which are well preserved in a number of specimens. The teeth and the tips of the chelæ are much lighter colored than the other portions. The portion of the shell about the base of the anterior pair of legs has a raised beaded edge. This portion is often broken away and variously placed in some of the specimens.

Of the posterior four pairs of legs we have with the help of one specimen obtained in 1904 (Pl. 2, Fig. 2), a knowledge of all the parts. This specimen had the last four joints of a single leg very well preserved. The main characteristic of these appendages is the great length of the fourth joints. These joints are considerably flattened in some cases but usually appear in cross section as shown in Pl. 2, Fig. 13.

Certain of the specimens preserved in the concretions show the internal characters very well. The doubly triangular skeletal mass shown in Pl. 2, Fig. 5, is often seen perfectly preserved. The divisions of the posterior part of the body are also seen in the same figure. In rare cases the gills are found lying in their cavities. In one case a small piece was taken out, softened and mounted. In this condition it showed the tubes and something of the structure of the gill. Apparently it was simply dried and not in any degree impregnated by mineral matter. A small rod-like mass is often seen when the front is broken away exposing the interior.

Altogether it seems that we now have a very fair knowledge of this Miocene species. In Pl. 1, Fig. 3, is given a restoration of this species from the specimens studied.

Cancer proavitus Packard.

Cancer proavitus Packard, *Proc. Amer. Acad. Arts and Sci.*, vol. 36, no. 1, July, 1900, p. 3, pl. 1, figs. 1–3.

Of all the specimens examined there seems to be but one which is in any way referable to this species. This specimen from the white leached layer already mentioned, consists of the cast of the sternum, abdomen, and outer maxilliped of a small female individual. Its main characters are shown in Pl. 2, Fig. 14. From a study of the type the specimen is referred to this species as it seems to be a Cancer and is from the same bed as was the type of this species. The type was a male and this is in all probability a small female of the same species. It will be at once seen that it cannot be referred to Archæoplax, which has

a very different sternum, abdomen, and outer maxilliped from that shown in the specimen under discussion. This species represented by the male specimen and the hand originally described, and now by this cast of the under side of a female, shows that it must have been far less common than the Archæoplax. Further search, however, should yield more specimens of this species. I am greatly indebted to Dr. Walter Faxon of the Museum of Comparative Zoölogy for help in placing this specimen in its present position, for although its condition would not give its complete relations there was nothing to preclude its being a Cancer.

Many of the Archæoplax had specimens of *Balanus concavus* Bronn attached to the carapace, as has been already noted in a previous paper.

Boston Society of Natural History,
March, 1905.

Explanation of Plates.

Plate 1. Natural size.

Fig. 1. Outline of side view of a typical carapace.
Fig. 2. Outline of front view of section through middle of carapace.
Fig. 3. Restoration of *Archæoplax signifera*, dorsal view.

Plate 2. $\frac{3}{4}$ natural size.

Fig. 1. Ventral view, sternum and joints of front leg (B. S. N. H. no. 12,946).
Fig. 2. Last four joints of one of the walking legs (B. S. N. H. no. 12,914).
Fig. 3. Color pattern of one side of carapace (M. C. Z.).
Fig. 4. Color pattern of small specimen from inside (B. S. N. H. no. 12,969). $\times 2\frac{1}{2}$.
Fig. 5. Specimen broken open showing antennules, plates of interior, and double triangular plate (B. S. N. H. no. 12,945).
Fig. 6. Synthetic figure from ventral side.
Fig. 7. Portion of hand and finger with teeth (B. S. N. H. no. 12,941).
Fig. 8. Portion of two chelæ, partly broken (B. S. N. H no. 12,942).
Fig. 9. Ventral view of sternum, abdomen, maxilliped, basal joints of legs and portion of chela (M. C. Z.).
Fig. 10. Abdomen of female (B. S. N. H. no. 12,940).
Fig. 11. Specimen showing abdominal appendages (B. S. N. H. no. 12,943).
Fig. 12. Outer maxilliped of right side (B. S. N. H. no. 12,947).
Fig. 13. Outline of section of one of the rear legs.
Fig. 14. *Cancer proavitus*, portion of abdomen, sternum, maxilliped, and basal joints of two legs (B. S. N. H. no. 12,970).

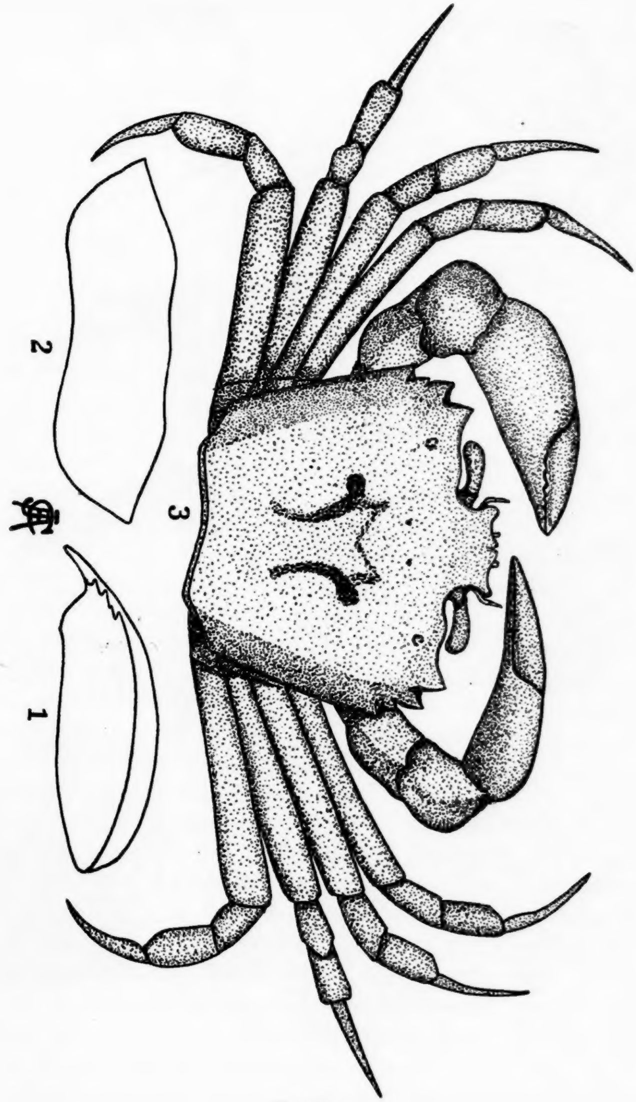

PLATE 1.

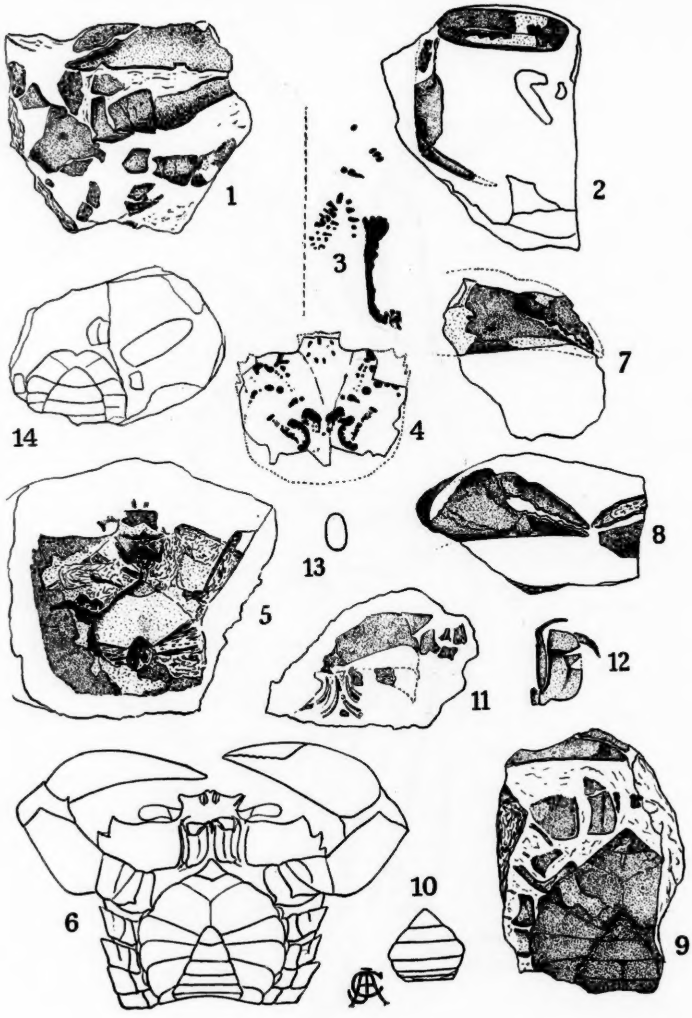

PLATE 2.

CONTRIBUTIONS FROM THE ZOÖLOGICAL LABORATORY OF THE MUSEUM OF COMPARATIVE ZOÖLOGY AT HARVARD COLLEGE. E. L. MARK, DIRECTOR. NO. 167.

A CASE OF ABNORMAL VENOUS SYSTEM IN *NECTURUS MACULATUS*.

THEODORE H. ROMEISER.

In all classes of vertebrates variations in the morphology of the circulatory system are by no means infrequent. Indeed, one rarely, if ever, finds two individuals with precisely the same arrangement of the blood-vessels. Even in cases in which the vessels are for the most part symmetrical, the smaller vessels, particularly the veins, are found to vary more or less on opposite sides of the body, as is readily shown by a comparison of the superficial veins of one's own forearms or the backs of the hands.

The literature on abnormalities of the blood-vessels shows that they often may involve even the largest and most important veins of the body, such as the postcava and its tributaries. It has been observed that in the venous system of some vertebrates the cases of variation are more frequent than those of the "normal" condition. Thus McClure (:00 a) finds variations in the opossum of such frequent occurrence and of so definite a character as to suggest probable phylogenetic relations.

The literature on abnormalities of the veins in Urodela shows records of several cases, mostly in European salamanders. Hochstetter ('88, p. 164) describes a condition in *Salamandra maculosa* in which the postcava did not pass through the liver, but was continuous with the much enlarged right posterior cardinal vein, the two forming a single vessel passing straight to the venous sinus. He also briefly mentions similar abnormalities seen in specimens of *Siredon pisciformis*.

Joseph (:01) observed in *Salamandra maculosa* a similar case,

in which, however, it was the left cardinal that was hypertrophied. In another case (also *S. maculosa*) described by Joseph, there were two abnormally large, symmetrical veins on the ventral surface of the liver, one on each side of the suspensory ligament. (Normally, according to Hochstetter, there is but one large hepatic vein, which is in the left half of the liver.) They ended separately in the venous sinus, which was, in his opinion, the enlarged end of the left vein. The right vein he found continuous with the postcava within the liver. According to his description and figures, the postcava entered the dorsal surface of the posterior end of the liver, passed forward through the liver substance, as it does normally, then became continuous with the right superficial vein ventrally, near the junction of the anterior and middle thirds of the liver.

The following anomaly was observed in the veins of a specimen of *Necturus maculatus* injected for dissection of the vascular system. The work was done in connection with the course on comparative anatomy given by Dr. H. W. Rand at Harvard University. Although annually for some years past many of these amphibians have been used for dissection and injection, no similar condition has been noted. This case is of interest, not only on account of its rarity and the profound alterations involving the chief veins of the body, but also because it is, so far as I know, the first instance of the kind observed in Necturus. Moreover, it differs markedly from all similar cases previously reported. Before giving an account of this abnormal condition, it may be well to describe briefly the normal arrangement of the corresponding veins.

The postcava (Fig. 1) begins as a median trunk lying between the kidneys; passes anteriad ventral to the aorta, which it leaves at a point near the posterior border of the liver; bends ventrad to enter the dorsal surface of the posterior end of the liver, through which it passes anteriad and within which it receives the hepatic veins; emerges on the ventral surface of the anterior end of the liver; bifurcates, then reunites and ends in (or rather is continuous with) the venous sinus at the point where the ducts of Cuvier enter laterally. The right and left posterior cardinals arise from the convexity of the bend in the postcava

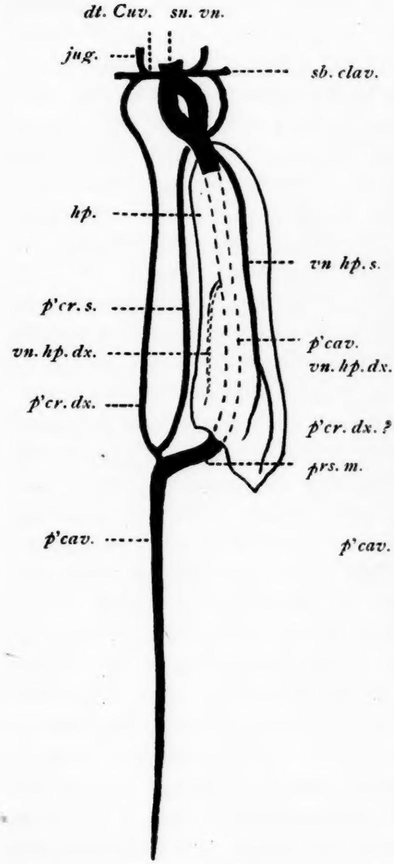

FIG. 1.

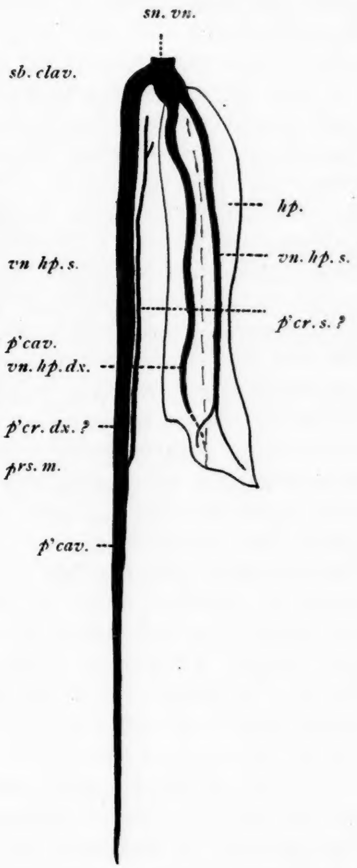

FIG. 2.

The figures represent the central portion of the venous system of *Necturus maculatus* seen from the ventral side and are about one half natural size. The liver is shown displaced slightly to the left of the median plane. Fig. 1 represents the normal condition, the veins within the liver being indicated by broken lines. In Fig. 2 the attachment of the suspensory ligament is indicated by a broken line. *dt. Cuv.*, duct of Cuvier; *hp.*, liver; *jug.*, jugular vein; *p'cav.*, postcava; *p'cr. dx.*, right posterior cardinal vein; *p'cr. s.*, left posterior cardinal vein; *prs. m.*, "Mittelstück" of postcava; *sb. clav.*, subclavian vein; *sn. vn.*, venous sinus; *vn. hp. dx.*, right hepatic vein; *vn. hp. s.*, left hepatic vein.

where it leaves the aorta, and they pass anteriad to terminate in the corresponding ducts of Cuvier, close to the venous sinus. The cardinals may arise from the postcava either separately or by a short common trunk. According to Miller (:00), the latter condition is the more usual. Posteriorly the cardinals anastomose with the renal portals, which have been omitted from the figure as not bearing upon the abnormalities here considered. The hepatic veins are variable in number, size, and termination; but Miller finds that two are larger and more constant than the others. One joins the postcava near the center, the other at the anterior end, of the liver. It is to be noted that in *Salamandra maculosa* there is normally but one large hepatic vein, which is in the left half of the liver (Hochstetter).

In the abnormal case (Fig. 2) the postcava arose normally between the kidneys, but instead of entering the liver, it became continuous anteriorly with a large and apparently median vessel which passed directly anteriad along the dorsal body wall to the heart, without receiving any hepatic veins. The end toward the heart lay somewhat to the right of the median plane and entered the venous sinus from the right side. The hepatics were two very large symmetrical veins, superficial on the ventral side of the liver for their entire length, one on each side of the suspensory ligament. They united at the anterior end of the liver to form a short, bulbous trunk, the anterior end of which was directly continuous with the venous sinus. The left hepatic vein was fairly straight and arose from the posterior end of the liver, where it received a small superficial tributary from the right side of the posterior border. The right one, of about the same size, was more irregular in its course. Its beginning was imbedded in the substance of the liver on the right side of its posterior extremity. Both received small hepatic branches within the liver, as was shown by sectioning.

About one centimeter posterior to the venous sinus and to the left of the median plane, there arose from the body wall a small vein formed by the union of two short branches. In its course posteriad it gradually approached the large median vein described above and passed along its dorsal surface, to which it was intimately attached. Its size increased slightly as it passed

posteriad. By careful dissection it was separated to a point opposite the posterior extremity of the liver. Here it was unintentionally severed from the postcava at what is believed to have been its point of entrance, as it could not be traced any farther. Its junction with the postcava could not be determined positively on account of its small size, the injury to the delicate wall of the postcava, and the exudation of the injected starch mass. The identity of this vessel is open to question, but from its relations and course, and by analogy with the somewhat similar cases mentioned above, it was most probably the atrophied left posterior cardinal corresponding to the very much hypertrophied right posterior cardinal, which was functioning as the anterior part of the postcava.

No further abnormalities were observed in either the circulatory or other systems.

Comparing this case with the normal venous system and considering the development of the postcava, it is inferred that *the right hepatic vein* (*or at least the anterior part of it*) *represents the anterior part of the normal postcava, the normal "Mittelstück" of the postcava having failed to develop.* Wiedersheim ('98, p. 371), speaking of the development of the postcava in Amphibia, says: "Der vordere (Leber) Abschnitt entstammt offenbar zum Theil der rechten V. omphalo-mesenterica, zum Theil aber entsteht er unabhängig." Hochstetter ('88) states concerning the development of the postcava in Salamandra: "Das Wesentliche an der Hohlvenenbildung ist demnach die Verbindung zwischen Lebervenen und Cardinalvenen und die Verschmelzung der Cardinalvenen in ihrem Urnierenabschnitte" (p. 167); .... "diese Verschmelzung erfolgt übrigens erst ziemlich spät, nachdem der sich ganz selbständig entwickelnde Abschnitt der vorderen Hohlvene sich mit der rechten Cardinalvene in Verbindung gesetzt hat...." (p. 163). "Ausnahmsweise kommt es manchmal vor, dass die Entwicklung eines vorderen Hohlvenenabschnittes vollständig ausbleibt, dann bildet sich entweder die rechte oder linke Cardinalvene weiter aus und führt im erwachsenen Thiere das Blut der Nieren, Geschlechtsorgane und des Rumpfes dem Herzen zu" (p. 164).

In comparison with the abnormal cases previously described,

this case of Necturus possesses in the hypertrophied right posterior cardinal, the characteristics of one of Hochstetter's, and in the two large symmetrical hepatic veins, those of one of Joseph's, although, upon the whole, it is strikingly different from both.

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SIR CHARLES BLAGDEN, EARLIEST OF RHODE ISLAND ORNITHOLOGISTS.

REGINALD HEBER HOWE, JUNIOR.

I WAS interested, when compiling the Rhode Island, Massachusetts, and Vermont State lists, to notice the date of the first authentic record for any bird within the States named. The earliest Massachusetts record was of the Black Skimmer (*Rhynchops nigra*) recorded in 1605 in the *Voyages of Samuel de Champlain*. The Vermont list contains accounts of observations made in 1794, by Samuel Williams, while the Rhode Island list dates from the writings of Edward A. Samuels in 1867. The ornithological literature of the State of Maine dates from the *History* of that State by William D. Williamson, published in 1832; that of New Hampshire from the work of Jeremy Belknap in 1792; and that of Connecticut from early in the nineteenth century. That Rhode Island has always been neglected is evidenced by the minimum of literature and the lack of material from the State, in all the collections of the country.

Through the kindness of Mr. William Brewster, I have lately received a copy of the *Bulletin of the New York Public Library* (vol. 7, no. 11, Nov., 1903, pp. 407–446), containing a number of letters from Sir Charles Blagden to Sir Joseph Banks, written from 1776–1780.

Sir Charles Blagden, physician, was born on April 17, 1748. He graduated from the University of Edinburgh, and entered the army as a medical officer, remaining in service until 1814. During the Revolution he was stationed at Charleston, Reedy Island, Delaware, New York, and Newport. He was on intimate terms with Cavendish, the famous chemist, who bequeathed him £16,000. He was also a friend, for fifty years, of Sir Joseph Banks, president of the Royal Society, and he himself was elected secretary of this Society in 1784. He has been described as a "careful worker in physical research," and Dr.

Samuel Johnson, according to Boswell, called him "a delightful fellow." In 1789, he was elected a correspondent of the Académie des Sciences of Paris. On March 26, 1820, he died at Arcueil, Paris, at the home of his friend Berthollet, the renowned chemist.

Sir Joseph Banks was born on February 13, 1743. He attended Harrow and Eton where he was early interested in botany. He afterwards entered Christ College, Oxford, where he became interested in general natural history. From 1768 until 1771, he fitted out and accompanied Cook's expedition on board the "*Endeavor*." He died at Isleworth, June 19, 1820, and his collections and herbarium were finally placed in the British Museum, where it is not improbable some of the Rhode Island animals collected by Blagden, were sent.

One of the letters under date of October 28, 1777, states that the specimens were sent to Europe on "the Brigantine Betsy, a Navy Victualer" in "twelve Kegs" "preserved in Rum" and Blagden writes: "Upon my appointment to the employment which brought me hither, Mr. Barrington desired that I would collect what things fell in my way for the use of his friend Mr. Lever. After considering as maturely as I could what would best answer everybody's purpose, I thought that desiring you & Mr. Barrington to accept the collection jointly between you, would be the properest step. Mr. Lever[1] wants anything that he happens not to have in his Museum, whether it tends to illustrate Science or not; on the contrary nothing can be an object to you but what will conduce to the improvement of Natural History as a branch of Philosophy. . . . . All my apprehensions are, lest the coolness which has subsisted between you & Mr. B. should make this division unpleasant; but if it be possible, wave that on the present occasion out of your friendship to me; if it be not possible, the last resource is, that you will each be so kind as to take six kegs apiece: At the same time consider, that at least 19 out of 20 of the things sent must be mere

[1] Sir Ashton Lever "expended an immense fortune in the formation of . . . . the Leverian Museum" near Manchester, which later was removed to London, and was finally sold "by way of lottery" in 1785, to a Mr. Parkinson, who sold it by auction in 1805.

trumpery, fit only to be thrown upon the dunghill; for I took all that offered." Under date of March 2, 1778, Philadelphia, he again writes: "With respect to the Kegs from Rhode-Island, I should deem myself extremely unfortunate if they occasioned the least misunderstanding between you & Mr. Barrington, more especially as I am convinced that they scarcely contain anything worthy your attention; it would be extremely easy to divide them by your taking six apiece; but as Mr. Barrington had previously acquainted me with his intention of sending all that he should receive to Mr. Lever, I thought it would best answer both his purpose and yours, that he should give up to you every thing that was nondescript, (if there be any such) on condition of keeping all the remainder, among which there might be many specimens not yet in Mr. Lever's Museum, & therefore interesting to him though not to you."

Two of the letters — the first dated September 12, 1778, the second undated — contain an annotated list of animals collected in Rhode Island, which were sent home, evidently, by Sir Charles Blagden to Sir Joseph Banks in Europe. The number and sex of the specimens were curiously designated in the following manner: "A string is tied to some part of the animal with its two ends of a length suited to the number to be expressed; every *single* knot on either or both of these ends stands for a unit; every *double* knot, that is, two single knots close together, stands for 10; and a *loop* at one end of the string means 100. .... Where I got a male & female the knotted string was tied to the right leg of the former & to the left leg of the latter."

The birds, which are the subject of this paper, were collected in Rhode Island, and most of them are to be positively identified from the names and descriptive notes. Many of the vernacular names he used are still in use in the State as local cognomens of species; *e. g.*, wamp, for the Eider (*Somateria dresseri*).

Under date of April 10, 1779, New York, he again writes that a Captain Davies "seems to have got every thing" in this country "that was brought to me in Rhode Island, except the Scapog-bird mentioned in my catalogue, which, I believe, he never saw."

Of the seventy-nine birds listed, the following species, I conclude, are almost unmistakably indicated by Sir Charles Blagden. Only the notes as to their comparative abundance are given.

LIST.

1. "No. 2," "Diver" or "Loon" = *Gavia lumme*; "Feb. 18."

2. "No. 3," "Sparrow-Hawk" or "Pigeon-Hawk" = *Falco sparverius* probably, from date of capture. "Feb. 20."

3. "No. 4," "yellow-Bird" = *Astragalinus tristis*. "Feb. 24," also "Apr. 15"?

4. "No. 5," "Blue-Bird" = *Sialia sialis*. "Mar. 15."

5. "No. 6," "No. 42," and "No. 94," "Red-winged Blackbird" = *Agelaius phœniceus*; "male . . . . appeared here the 10th or 12th of March: in a fortnight or three weeks came the females."

6. "No. 7," "Robin" = *Merula migratoria*; "arrive . . . . about the middle of March, & in such quantities & so tame, that a dozen could be shot in an hour within two miles of the town."

7. "No. 8," "yellow Woodpecker" = *Colaptes auratus luteus*. "Mar. 19."

8. "No. 9," "Hildee" = *Oxyechus vociferus*. "March 24."

9. "No. 10," "Snipe" = *Gallinago delicata*. "Mar. 24."

10. "No. 12," "Wamp" = *Somateria dresseri*. "Mar. 25" and "Ap. 9."

11. "No. 13," "Red-billed Coot" = *Oidemia americana*. "Mar. 25."

12. "No. 14," and "No. 15"? "Beach-Bird, or Snipe Beach-Bird" = *Calidris arenaria*. "Mar. 25."

13. "No. 16," "Marsh-Quail" = *Sturnella magna*. "Ap. 1."

14. "Great Loon" = *Gavia imber*; one was shot "April the 5."

15. "No. 17" and "No. 28," "Bald-pated Coot" = *Oidemia perspicillata*. "Ap. 3."

16. "No. 18" and "No. 23," "Old Wife" = *Harelda hyemalis*. "Ap. 3" and "Ap. 8."

17. "No. 19," "Sheldrake" = *Merganser serrator.* "Very plenty." "Ap. 3."

18. "No. 22," "Parrot-Bill," "Noddy" or "Murr" = *Alca torda*; "a rare bird here." "Ap. 10."

19. "No. 24," "Dipper" = *Erismatura jamaicensis*; "very common." "Ap. 8."

20. "No. 25," "Loon" = *Colymbus auritus.* "Ap. 8."

21. "No. 27," "Brant" = *Branta bernicla.* "In Spring, with a southerly wind, prodigious flocks pass close to Sachawest point." "Ap. 13."

22. "No. 29," "White-wing" = *Oidemia deglandi.* "Ap. 13."

23. "No. 30," "Crow Black-bird" = *Quiscalus quiscula* + *aeneus.* "April."

24. "No. 33," "Cormorant" = *Phalacrocorax auritus* or *carbo*, perhaps both. "Harbour in large quantities on a rock about 2 miles from Sachawest Point, thence called Cormorant Rock." "Ap. 22."

25. "No. 35," "Common Swallow" = *Hirundo erythrogaster.* "Ap. 23."

26. "No. 37," "Pewit" = *Actitis macularia.*

27. "No. 40," "Grass-Plover" = *Bartramia longicauda.* Perhaps *Charadrius dominicus*? "They come in great numbers & are very tame at first, but grow extremely shy & and hard to shoot in a few days. Ap. 29."

28. "No. 43," "Woodcock" = *Philohela minor*; "there are Woodcock's nests in woods of most of the Islands round Rhode Island." "May 6."

29. "No. 46," "black-breasted Plover" = *Squatarola squatarola.* "Lately migrated to the Island; in flocks. May 9." "May 16."

30. "No. 47," and "No. 61," "Tell-tale Plover," "yellow-legged Plover" = *Totanus melanoleucus.* "May 11" and "May 15."

31. "No. 48," "Ox-eye" = *Ereunetes pusillus* "begins to come in large flocks to the ponds near the beach May 11."

32. "No. 49," "ring-necked Plover" = *Ægialitis semipalmata.* "May 11."

33. "No. 50," "King-bird" = *Tyrannus tyrannus.* "May 12."

34. "No. 51," "Quongquéedle" = *Dolichonyx oryzivorus.* "The males appear some time before the females, — which then appear all of a sudden & pair immediately." "May 13."

35. "No. 54," "common Chipbird" = *Spizella socialis.* "Frequenting the gardens April 23d."

36. "No. 55" and "62," and "67," "Rock-Plover," "red-legged Plover," "Whale-Bird" = *Arenaria interpres.* "May 13." "May 15." "May 16."

37. "No. 57," = *Empidonax minimus.* "Frequent in gardens. May 13 & 16."

38. "No. 58," "Thrasher or Thrush" = *Toxostoma rufum.* "Pretty common." "May 13."

39. "63," "Mosquito Gull" = *Sterna antillarum*; "very frequent about ponds near the beaches." "May 15" (see text following "No. 102"). "July the 2d I shot a Mosquito Gull No. 63 with the Minow No. 45 in its mouth, which it was taking to the young then hid in the sand near the beach."

40. "64," "Humming-Bird" = *Trochilus colubris.* "May 15."

41. "68," "common wild goose" = *Branta canadensis.*

42. "69," "Night-Hawk" = *Chordeiles virginianus*; "very common." "May 16."

43. "No. 70," "Wren" = *Troglodytes aëdon*; "found about shrubs in gardens." "May 16."

44. "72," "Cat-bird" = *Galeoscoptes carolinensis.* "May 17."

45. "No. 73," "Fool Plover" = *Macrorhamphus griseus.* Fool Plover is to-day a local name for this species. "May 20."

46. "75" and "No. 96," "Shike-poke" or "Quawk" = *Nycticorax nycticorax nævius.* "May 22" and "June 19." Perhaps the former name refers to *Butorides virescens*, but it is universally called in the State "Fly-up-the-creek."

47. "76," "Mackarel Gull" = *Sterna hirundo.* "May 24."

48. "80," "red-headed Woodpecker" = *Melanerpes erythrocephalus.* Perhaps *Sphyrapicus varius.* "June 1."

49. "82," "common crow" = *Corvus brachyrhynchos.*

50. "No. 87," "American Cuckoo" = *Coccyzus erythrophthalmus*; probably, because the more common. "June 15."

51. "No. 90," "Tree Heron" = *Nyctanassa violacea*; "very rare." "June 15."

52. "No. 91," "Chimney Swallow" = *Chætura pelagica*; "more common in the inland parts than near the seacoast." "June 15."

53. "No. 92," "Fulica Chloropus" = *Gallinula galeata*; "very rare." "Jun. 16."

54. "No. 93," "Whistling Quail" = *Colinus virginianus*; "common." "Found all the year."

55. "No. 97," "Bank Swallow" = *Riparia riparia.* "June 19."

56. "No. 103," "Whipperwill" = *Antrostomus vociferus.* "Jul. 3."

57. "No. 105," "wild Pidgeon" = *Ectopistes migratorius.* "Jul. 7." Evidently about June 19 "some flights . . . . came over the Island, but the great flocks are not found nearer the sea than Providence."

58. "No. 107," "Gull," "*Sterna nigra*" = *Hydrochelidon nigra surinamensis.* "Jul. 14."

59. "No. 108," "Kingfisher" = *Ceryle alcyon.* "July 14."

60. "Broad-bill" = *Aythya marila.*

Of Doubtful Recognition.

1. "No. 1," "Common Sparrow" = *Spizella monticola* or *Melospiza cinerea melodia.* "Feb. 18."

2. "No. 12," "Whi[s]tling Diver" = *Clangula clangula americana*?; "coarse species of the Sea Wild Duck, very common. Mar. 25."

3. "wood-pecker" or "Picus hirundo" = *Dryobates pubescens medianus*? Seen "April the 8th."

4. "No. 26," "Loon" or "Colymbus Immer" = *Gavia lumme*? "Ap. 13." "Weighed three pounds."

5. "No. 32," "wood-pecker" = ? "Ap. 17."

6. "No. 34," "Ground Sparrow" = *Spizella pusilla*? "Ap. 23." "Chirps, cannot sing." It is interesting to note that Wilson did not know the Field Sparrow's song.

7. "No. 36," "common Swallow" = *Iridoprocne bicolor* ? "Ap. 23."

8. "No. 52," "Goldfinch" = *Carpodacus purpureus* ? "May 13th."

9. "No. 53," "Chip-bird" = ? "May 13."

10. "No. 56," "common Swallow" = *Progne subis* ? "April 23."

11. "No. 66," "Grasshopper Gull" = *Larus "canus" argentatus*. "May 16."

12. "No. 65," "Plover" = ? "May 16."

13. "71," "Scapog-Bird" = *Hæmatopus palliatus* or *Rhynchops nigra* ? If either of these is the bird mentioned it makes the only record of occurrence in Rhode Island.

14. "No. 77," "Gull" = ? "May 24."

15. "79," "Port Royal Bird" = *Ampelis cedrorum* ? "rare." "May 29."

16. "No. 83," "bee-bird" = *Tyrannus tyrannus* ? "June 7."

17. "84," "dipdapper" = ? "June 7."

18. "No. 101," "yellow bird" = *Dendroica æstiva* ? "June 26."

19. "No. 104," "black snipe" = *Helodromas solitarius* ? "Jul. 4."

THE LITERATURE OF EDESTUS.

C. R. EASTMAN.

It has happened not infrequently that discoveries of the most surprising nature in paleontology have been made almost simultaneously in different parts of the world. Hardly has some form of animal life, previously unheard of and apparently unique, been brought to light, when identical or closely related types are reported from remote regions. Familiar coincidences of this nature are recalled by Pareiasaurus amongst reptiles, Helicoprion amongst fishes, and Dæmonhelix amongst problematical fossils.

Although our knowledge of Helicoprion is comparatively recent, a very considerable literature has suddenly sprung into being concerning it and related forms, of which the older-known Edestus and Campodus are the most instructive and important. The latter, in fact, provides the only satisfactory clue we possess regarding the anatomical and systematic position of the whole series of Edestus-like forms.

Without entering into any general discussion, it may be said that the majority of writers concur in the opinion that the "spiral saw" of Helicoprion and the arched segments of Edestus represent stages of that peculiar modification amongst Paleozoic sharks whereby series of teeth become fused and inrolled without being shed. The most recent communication that has appeared on this subject strikes a slightly discordant note, in that the author, Mr. Edwin T. Newton,[1] suggests that Helicoprion and Edestus may not be of the same general nature after all. Although admitting that the former may be very plausibly regarded "as the enrolled dentition at or near the symphysis of an Elasmobranch, possibly allied to Cestracionts," his interpretation of Edestus is that it is a segmented dermal defence, such as a dorsal fin-spine.

[1] Newton, E. T. On the Occurrence of Edestus in the Coal-Measures of Britain. *Quart. Journ. Geol. Soc.*, vol. 60, 1904, pp. 1–8, pl. 1.

As has just been observed, a key to the understanding of Edestus-like forms is furnished by the symphysial dentition of Campodus, and there lies at hand a simple and reliable test for demonstrating their common plan of structure. For those who have not actual specimens at command, recourse must be had to plaster casts of Campodus and Edestus, which fortunately are not rare among the larger museums of this country. If one will place side by side the symphysial segments of *Campodus variabilis* and *Edestus heinrichi*, orienting them in natural position with the anterior end foremost, one will be struck by their almost perfect correspondence, part for part, and line for line.

First and most conspicuously, it will be noted that the coronal apices of Campodus and Edestus are similarly formed, their edges being denticulated and sides striated in corresponding manner. It will be seen further that the basal portion of the crown projects forward characteristically in both forms, and that the different segments overlap and are fused with one another in an identical fashion. Only in Edestus is the peculiar trough-like base much produced forwardly, and being composed of vasodentine, is usually well preserved, whereas in Campodus the basal support for the teeth is cartilaginous, and hence unsuited for preservation. But the structural resemblance of all parts is so obvious, especially when one occupies himself with original specimens, that the idea of a homology existing between them cannot be avoided. In fact, the evidence appears conclusive that Campodus, Edestus, and Helicoprion represent successive stages of modification amongst Cestraciont sharks. The importance of these forms from a morphological standpoint is such, and the discussion of them so widespread, that it seems desirable to draw up an index to their special literature, which is given below.

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NOTES AND LITERATURE.

ZOÖLOGY.

Guide to the Birds of New England and New York.[1] — This guide to the birds is on the same general plan as a number of recent bird-books, but the effort has been made to adapt it especially to the most elementary beginners. For this purpose it appears to be well fitted, and the author is to be complimented upon his constant appreciation of the limited view-point of the novice in bird study. Brief introductory chapters deal with "The object and plan of this guide," "Birds and their seasons," "Migration," "Distribution," "Hints for field work," and "How to use the keys." The result of intimate experience with beginning field classes is apparent in these hints.

The keys include only "the common land-birds of New England and eastern New York," omitting "the hawks, the owls, the Mourning Dove, and the game-birds." Separate keys are given respectively for winter, for March, for April, for May, for summer, and for autumn, and each of these has under separate divisions those birds which one may expect to find only in the Upper Austral or the Canadian life-zones. These keys are based primarily upon conspicuous coloration and secondarily upon size, supplemented by characteristics of color, habits or habitat. Taken in connection with the fuller descriptions, and often excellent, brief biographies given in the body of the work, they impress one as being very efficient. In the descriptive portion are incorporated the water birds and others not included in the scope of the keys, and one cannot but regret that some guide is not given to aid in their identification as well. The illustrations consist of five full-page plates, including a map showing the life-zones in New England, and ninety-five text figures, which add much to the usefulness of the book.

L. J. C.

Hornaday's American Natural History.[2] — It is perhaps unfor-

[1] Hoffmann, Ralph. *A Guide to the Birds of New England and New York.* Boston and New York, Houghton, Mifflin & Co., 1904. 8vo, xiii + 357 pp.

[2] Hornaday, William T. *The American Natural History. A foundation of useful knowledge of the higher animals of North America.* Illustrated by 227 original drawings by Beard, Rungius, Sawyer, and others, 116 photographs, chiefly by Sanborn, Keller, and Underwood, and numerous charts and maps. Charles Scribner's Sons, New York, 1904. Large 8vo, xxv + 449 pp.

tunate that a work dealing with the vertebrates only should pre-empt such a broad title as "The American Natural History," which, without the accompanying subtitle, is apt to be rather misleading. The latter, "A foundation of useful knowledge of the higher animals of North America," is much more nearly descriptive of the character of the book in hand. As the author states in his preface, it has been his primary intention to provide for the boys and girls of North America between the ages of fourteen or fifteen and the age at which they usually enter the university, an introduction to the "higher animals" of the continent, in a form that will be interesting and pleasing as well as instructive; also to furnish a book of reference for teachers in the intermediate grades. All who have read Mr. Hornaday's "Two Years in the Jungle" are aware of his ability to write entertainingly, and his years of experience in the field and in the New York Zoölogical Park have given him opportunities for studying the living animals such as comparatively few men have had. These advantages have been combined to make "The American Natural History" good and instructive reading, not only for young people, but for any who have a limited acquaintance with our animals.

In general, only the commoner forms have been selected for treatment, but in some cases descriptions are given of the rarer species, while a number of exotic animals, such as the Monotremes, the fruit-eating bats, etc., are introduced to fill the gaps in the North American fauna. The treatment of the various forms varies considerably, apparently to a large extent with the author's interest. The portion dealing with the Ungulates is especially extensive and contains much original information gained from experience with the animals in captivity. Throughout the work a special point has been made of refuting popular fallacies, such as, that beavers use their tails as trowels, that porcupines shoot their quills, that mountain sheep alight on their horns, and that the hog-nosed snake is poisonous, — a feature which should be conducive of good results. Protection, especially of the game animals, has also received considerable attention and emphasis, a subject which it is well to bring to the attention of the public whenever possible.

The illustrations are numerous, and in most cases excellent. This is especially true of the reproductions of photographs, which cannot be praised too highly; but on the other hand, some of the drawings, especially of the mammals and fishes, seem hardly up to the standard of the day, at least in artistic effect. One cannot but wish that in

some cases the backgrounds had been omitted entirely, as in the figure of the sawfish (p. 435), the chimera (p. 431), and others. It is a question, too, whether the painting-in of other backgrounds in photographs is legitimate in a book of this nature, and whether it is not apt to be misleading to beginners when no explanation is given. One might imagine, for example, that the puma (p. 20) is a docile beast which poses calmly in its mountain home in order to be photographed; see also the polar bear (p. 36), the flamingo (p. 266), etc. The "landscape charts" used to illustrate relationships and habitat seem rather strained and overdrawn, while these and the text are somewhat misleading in constantly referring to animals as "higher" and "lower," tending to give the student an idea that the vertebrate affinities lie in a direct chain, rather than forming a complicated, branching system.

Mistakes of fact are by no means lacking, especially points in the anatomy of the exotic species; and the classification is throughout largely artificial and based upon superficial resemblances and analogies.

In the introduction the author makes some very conservative remarks regarding the tendency to humanize animals and to ascribe to them a higher order of intelligence than they possess; but unfortunately he has in many cases been unable to avoid at least the semblance of the fault himself, as when he says (p. 93): "*The most humorous of all rat-like animals* is the Trading Rat, ... which delights in playing practical jokes upon its human neighbors." He is perhaps inclined at times, too, to make over-positive statements which cannot be taken quite literally.

This book will probably not become generally used as an intermediate text-book; but it will be found a partial substitute for those who have no opportunity to visit a good zoölogical park, and will certainly add greatly to the pleasure of those who do have that privilege. It is an excellent work for home reading and reference.

L. J. C.

Notes. — The zoögeographical relations of South America recently have been discussed by Dr. G. Pfeffer (*Zoöl. Jahrb.*, Suppl. 8, 1905, pp. 407–442), with reference to the reptiles, amphibians, and fishes, especially as to the question of the former land connections of this continent with Africa and with Australia. It is apparently the desire of the author to demonstrate that there is no evidence whatever for the assumption of such connections, and, consequently, the paper

chiefly discusses those cases, which are not in favor of the former land connection between these continents, that is to say, which do not directly bear upon this question, while other cases, which might possibly furnish additional evidence are dismissed shortly.

The general trend of Pfeffer's argumentation is as follows. There are a number of instances, where discontinuous distribution in all or some of the southern continents is evidently a remnant of a former universal or subuniversal distribution, which is clearly shown by the presence of fossil remains of the several groups of animals in other parts of the world. On the other hand, there are similar cases, in which fossil remains are not known at all, or are not known from the northern continents. Here, Pfeffer claims, we have the right to assume, that these groups nevertheless once existed on the northern hemisphere, and they also once were subuniversal in their distribution.

Here we are again confronted with a fallacious generalization of correct observations, a way of drawing conclusions that has so often given origin to incorrect general theories. Of course, if some groups of animals, that are now more or less restricted, were once universal in their distribution, it is evident, that very likely some others were, of which no direct evidence of universality has been found. But the conclusion, that all such cases are to be explained by this assumption, is, to say the least, a little rash. Moreover, we do not intend to find a theory that might under certain assumptions explain the present facts, but we ought to try to find the correct explanation, and thus no way of ascertaining the latter should be neglected, and doubtful cases should not be dismissed shortly, but subjected to a careful and thorough study.

In the present paper, Pfeffer only talks of paleontological evidence, and almost entirely neglects the morphological (systematic) relations of the different forms. It is sufficient for him, if certain forms are found in Africa and South America, to point out that they might have been once present also in North America and Eurasia, and that thus a connection may be established (over Bering Sea). If similar forms are also found in India, this assumption seems to him beyond question. He does not pay the slightest attention to the mutual relations of these forms.

Now it is a fact, that the former land connections between tropical South America and Africa, and between southern South Africa and Australia have been supported chiefly by studies of the degree of the relation of their faunas. We know cases where members of the

fauna of South America find allied forms in many parts of the world, but where the most closely allied forms are found in Australia ; in other cases, the nearest relations are found in West Africa. For such cases the theory of former subuniversal distribution is entirely insufficient, and only leads to the further question, why it is, that from a former universal distribution, the most closely allied remnants are found in the most remote parts? For we must always bear in mind, that, if we do not admit direct connections between South America and Africa, and South America and Australia, the connection of these parts always goes by way of Bering Sea or Greenland.

Pfeffer himself mentions a number of instances, where the present distribution appears to favor a direct connection of the three southern continents, but he never studies them closely, and is satisfied with the conclusion that they very likely are also remnants of a former subuniversal distribution. The following are the most striking examples: *Chelonia*, family Miolaniidæ; *Lacertilia*, genus Mabuia, family Amphisbænidæ; *Ophidia*, families Typhlopidæ and Glauconiidæ, genus Leptodira; *Batrachia Anura*, families Pipidæ, Cystignathidæ, Hylidæ, and Engystomidæ; *Batrachia Apoda*, family Cœciliidæ; *Teleostei*, families Characinidæ, Symbranchidæ, Serranidæ, Cichlidæ.

I do not say that these groups actually furnish evidence for the supposed former connections of the southern continents; I only want to call attention to them, with a view to having them made the object of careful, detailed, and unprejudiced examination, paying principal attention to the mutual affinities of their representative members in the different parts of the world. Pfeffer has not done this, and thus his treatment of these groups is superficial and unsatisfactory; in some of the above instances, objections to the assumption of former subuniversality of distribution are evident at the first glance.

Thus Pfeffer's final conclusion, that there is no necessity for the assumption of direct land connections between South America and Africa, and South America and Australia, upon zoögeographical grounds, is not properly supported even with reference to those groups which he made his special object of study in the present paper. In the face of the fact that there are other groups not mentioned and studied by Pfeffer, that have furnished positive evidence for these connections, and in which the assumption of former subuniversal distribution is entirely unsatisfactory, rendering the present conditions only more unintelligible, we get the impression that Pfeffer did not take up these studies with an unbiased mind.

One additional objection should be made. Pfeffer repeatedly talks of a pre-Tertiary South America, and of the separation of South America from the rest of the world at the end of the Cretaceous time (p. 411, p. 427, p. 430; "præpanamensisches Pan-America"). This tends to show that his ideas about the geological history of South America are entirely at variance with certain geological facts. We know that there was no South America at all as a continuous mass before the beginning of the Tertiary, and that the first connection of what is now South America with North America falls into the Miocene. For this we do not possess a mere theory, but positive geological facts; it is impossible to deny the existence of Jurassic and Cretaceous marine deposits over large parts of South America, or to neglect the fact of their existence. But if we pay due attention to this, then it is inadmissible to speak of a pre-Tertiary South America, and to talk of a severing-off of South America from the rest of the world at the end of the Cretaceous.

A. E. ORTMANN.

A detailed account of the anatomy of the chiton, *Cryptoplax larvæformis*, has been published by E. Wettstein (*Jena. Zeitschr.*, Bd. 38, p. 473).

N. Maclaren (*Jena. Zeitschr.*, Bd. 38, p. 573) discusses the structure and systematic relations of two trematodes, *Diplectanum æquans* Wagener and *Nemathobothrium molæ* n. sp.

Anatomy and Histology of Dentalium. — The following facts are recorded by M. Boissevain (*Jena. Zeitschr.*, Bd. 38, p. 553) on the anatomy and histology of Dentalium. The whole foot is ciliated and glandular. The intestinal musculature consists of a thin layer of circular fibers with occasional muscle bridges. The subradular organ carries an organ of taste. The communication between the genital glands and the kidney is renewed with each period of sexual activity.

F. A. Bather, in the *Geological Magazine* (dec. 5, vol. 2, p. 161) characterizes *Sympterura minveri*, n. g. et sp., a Devonian Ophiurid from Cornwall. The genus is thus diagnosed: a Lapworthurid with spinulose disc extending to second arm-segment, with oral skeleton of teeth, long jaws, and short mouth-frames (torus not seen), with free arm-segments containing a vertebral ossicle, possibly compound, grooved ventrally and provided on each side with two wings, to the distal of which is attached an adambulacral spiniferous element. The structure of the arm-segments suggests

that the vertebræ may be composed of two successive pairs of ambulacral elements, and reasons are given for suspecting that this may be the case in all the more advanced Ophiurids. The holotype of the species, which is the first echinoderm described from these Cornish slates, is in the British Museum.

In recent numbers of the *Bulletin du Musée Océanographique de Monaco*, E. Chevreux describes two new deep-sea amphipods, *Cyphocaris alicei* and *C. richardi*, from the waters between the Canaries and the Azores. G. O. Sars contributes the first part of a preliminary list of the Calanoids collected during the Prince of Monaco's deep-sea explorations. A list of the Symphyla and Diplopoda of the principality of Monaco is given by H. W. Brölemann.

The migratory movements of certain species of Pierids in the Amazon valley are described by Dr. Gœldi in vol. 4 of *Boletim do Museu Gœldi.* The same journal contains a list of the Brasilian birds described by Spix, Wied, Burmeister, and Pelzeln, and a catalogue of the mammals in the collection of the Para Museum. A number of interesting notes on the mammals are added and well executed plates illustrate several of the species.

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